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ENVIRONMENTAL INVENTORY AND ASSESSMENT OF THE PROPOSED NEW DELTA MINE EXPANSION IN SOUTHEASTERN ILLINOIS

Prepared by

Cooperative Wildlife Research Laboratory

Southern Illinois University

Carbondale, Illinois

December 1975

ENVIRONMENTAL INVENTORY AND ASSESSMENT OF THE PROPOSED NEW DELTA MINE EXPANSION IN SOUTHEASTERN ILLINOIS

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December 1975

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PART I: INTRODUCTION

AMAX Coal Company is planning to expand its Delta surface-mining activities in Williamson and Saline counties, Illinois. Major activities associated with this action will include: opening of a new 6,500-acre reserve field (Northwest Harrisburg Field); construction of the new Delta preparation plant; and construction of haulage roads to the new preparation plant.

Completion of these projects will cause at least temporary alteration of local terrestrial and aquatic environments and will require the filing of a Federal Environmental Impact Statement if a National Pollutant Discharge Elimination System permit must be obtained prior to discharging mine waste waters into streams. Consequently, the environmental changes which will occur as a result of the Delta mining operations must be carefully analyzed.

The project area, known as the Delta expansion area, includes about 8,129 acres in Saline County from the western county border east to Illinois Route 34 (T 9S, R 5E, S 1-18; T 9S, R 6E, S 4, 5, 6, and 7; T 8S, R 6E, S 32 and 33) and in east-central Williamson County (T 9S, R 4E, S 1 and 12). The study included the period of October 1974 through December 1975. Actual fieldwork covered three seasons from December through July; water samples were collected February through September.

Objectives

The primary objectives of the study were to: (1) describe and map the major soil types and land-use categories of the study area; (2) determine land-use trends; (3) assess present water quality; (4) identify and

describe the principal habitat types; (5) inventory the plants, mammals, birds, amphibians, reptiles, fishes, and macroinvertebrates associated with each habitat; and (6) document the rare and endangered species of the study area. Secondarily, the impact of mining on wildlife and reclamation aspects were to be discussed.

Description of the Study Area

Climate

The climate of southeastern Illinois is temperate continental with cold, rainy winters and warm, humid summers. The growing season averages 190-200 days (Ross and Case 1956). According to weather data for Harrisburg, Illinois, there were 193 and 206 frost-free days in 1972 and 1973, respectively (U. S. Dept. of Commerce, Environmental Data Service 1972 and 1973).

The mean annual precipitation at Harrisburg is 42.3 inches; total precipitation was 50.47 inches in 1972 and 50.34 inches in 1973 (Table 1). Spring, summer, and early fall precipitation comes largely in the form of showers or thunderstorms. Thunderstorms may occur during the winter months, but they are most frequent from April to August. Freezing rains can occur in the late fall, winter, and early spring months. Snowfall may occur in the area from November through March. Total snowfall in 1973 was 16 inches with a maximum daily of 8 inches in December (Table 1). It is unusual for the snow to stay for more than a week before melting.

The mean annual temperature at Harrisburg is 58.1°F; the mean temperature was 57.1°F in 1972 and 59.0°F in 1973 (Table 2). Temperatures rise above 90°F in June, July, and August and drop to around 25°F in December, January, and February. Temperatures below zero are infrequent.

Table 1. Maximum daily and total monthly precipitation recorded at Harrisburg, Illinois, 1972 and 1973.[1,2]

	1972		1973			
					Snowfall	
Month	Max	Total	Max	Total	Max	Total
January	0.88	2.16	1.15	3.57	1.0	1.0
February	1.35	2.85	0.53	1.38	1.0	1.5
March	1.05	5.10	1.45	6.14	T	T
April	1.61	2.73	2.56	6.69	0.5	0.5
May	2.67	4.58	3.40	7.54	0.0	0.0
June	0.60	1.37	0.63	3.37	0.0	0.0
July	1.04	4.71	0.86	2.31	0.0	0.0
August	1.30	3.91	1.28	1.68	0.0	0.0
September	0.97	5.69	1.30	2.80	0.0	0.0
October	1.86	3.64	0.83	2.54	0.0	0.0
November	1.36	4.87	2.52	7.09	0.0	0.0
December	2.18	4.73	1.55	5.23	8.0	13.0
Mean Annual	50.47(+8.19)*		50.34(+8.06)			

---

[1] U. S. Dept. of Commerce, Environmental Data Service (1972).

[2] U. S. Dept. of Commerce, Environmental Data Service (1973).

*Number in parentheses represents the departure from normal precipitation.

Table 2. Maximum, minimum, and mean monthly temperatures (°F) recorded at Harrisburg, Illinois, 1972 and 1973.[1,2]

	1972			1973		
Month	Max	Min	Mean	Max	Min	Mean
January	44.7	24.1	34.4	44.1	27.3	35.7
February	47.5	26.7	37.1	47.7	27.3	37.5
March	58.6	36.6	47.6	64.4	44.2	54.3
April	70.9	46.8	58.9	65.7	47.6	56.7
May	81.7	54.7	68.2	75.3	52.5	63.9
June	88.4	60.0	74.2	88.5	65.2	76.9
July	88.8	66.2	77.5	92.4	68.6	80.5
August	88.4	65.0	76.7	90.5	65.6	78.1
September	82.8	62.7	72.8	84.2	63.1	73.7
October	67.2	46.5	56.9	75.1	50.2	62.7
November	50.7	37.8	44.3	61.6	42.7	52.2
December	44.2	28.5	36.4	44.3	28.3	36.3
Mean Annual		57.1(-1.0)*			59.0(+0.9)	

---

[1] U. S. Dept. of Commerce, Environmental Data Service (1972).
[2] U. S. Dept. of Commerce, Environmental Data Service (1973).
*Number in parentheses represents the departure from normal temperature.

Total evaporation and wind movement recorded at the Carlyle Reservoir are listed in Table 3; the Carlyle Reservoir, located about 75 miles northwest of the study area, is the nearest station recording these parameters.

The study area is generally rural and, consequently, is relatively free of the air pollutants that commonly occur in urbanized areas. Except for a few coal-burning utilities, most air pollution is contributed by the traffic on Illinois Route 13, which abuts the study area on the south. Levels of particulate matter were available only for Carbondale, located about 30 miles west of the study area, and Marion, about 15 miles west of the area. The October and November level of particulate matter in Carbondale was 117 micrograms per cubic meter; 625 micrograms per cubic meter requires an air pollution watch and is the lowest level of alert in Illinois. In Marion for the same time period, the nitrogen dioxide (NO_2) level was 0.026 parts per million (ppm) and the sulfur dioxide (SO_2) level was 0.019 ppm; criteria for a "watch" are 0.400 ppm NO_2 and 0.300 ppm SO_2 (personal communication, 20 May 1975, Dept. of Community Development, City of Carbondale, Illinois).

Geology

The study area is a region of moderate relief with sandstone hills dissected by flat-floored valleys. The area east of the Harco Blacktop Road is dominated by flat bottomland, while that to the west is hillier with steeper slopes.

Bedrock of the area belongs to the Pennsylvanian, or "Coal Measure," system (McLeansboro age), and is visible along hillsides, channels of streams, and roadcuts (Cady 1925:6). The Pennsylvanian strata contain

Table 3. Total evaporation and wind movement recorded by month at the Carlyle Reservoir, 1972 and 1973.[1,2,3]

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1972												
EVAP	--*	--	--	4.68	7.73	10.07	8.84	6.88	--	3.52	--	--
WIND	--	--	--	3393	2131	2479	2500	1908	--	2333	--	--
Max	--	--	--	64.4	78.5	84.8	85.4	85.8	--	60.2	--	--
Min	--	--	--	44.8	54.5	56.4	63.5	63.3	--	43.6	--	--
1973												
EVAP	--	--	--	4.48	6.85	8.15	8.96	8.05	4.80	4.09	--	--
WIND	--	--	--	3479	2733	2108	1869	2032	1779	1970	--	--
Max	--	--	--	60.7	72.4	87.3	91.6	87.7	79.0	68.6	--	--
Min	--	--	--	43.7	50.1	62.2	65.6	63.0	59.7	49.3	--	--

---

[1] U. S. Dept. of Commerce, Environmental Data Service (1972).

[2] U. S. Dept. of Commerce, Environmental Data Service (1973).

[3] Evaporation is measured in the standard Weather Service-type pan of 4-foot diameter. Max and Min values in the table are monthly averages of daily extremes of temperature of water in the pan as recorded during 24 hours ending at time of observation. Wind is the total wind movement in miles over the evaporation pan as determined by a continuous anemometer recorder located 6-8 inches above the pan.

*No data recorded.

four overburden groups, three of which may be encountered in surface-mining in the study area. The Tradewater group is at the greatest depth and contains numerous coal beds overlain by thick sandstone and shale. The Carbondale group is characterized by thicker coal beds than the Tradewater group; but, sandstones are less prominent while shale and limestone developments are more numerous. Strippable coal of the McLeansboro group is in limited areas of Saline and Williamson counties. Here limestones are highly developed, overlain by deposits of sandstone. In general, most strippable coal seams of the study area lie 50-150 feet from the surface and are over 4 feet thick (Smith 1957).

Five fault lines occur in the geological structure: (1) the Corinth fault which runs north, about 60° east from the Williamson-Saline county line; (2) the Brushy anticline in sections 4, 5, 8, and 9, Brushy Township (T 9S, R 5E); (3) the trough running parallel with and south of the Corinth fault and Brushy anticline; (4) Brushy Creek fault running north, about 25° east of a line about 1/2 mile west of Bankston Fork Church (T 9S, R 5E, S 10); and (5) Bankston Fork fault crossing the northwest quarter of section 12, Brushy Township (Cady 1925:11). Except for the latter, surface evidence is known for all these structures.

PART II: SOILS

The western three-fourths of the Delta expansion area is located in Brushy Township in Saline County, which lies within the Mount Vernon Hill Country of the Tills Plain Section. This physiographic unit is characterized by topography with low relief, restricted upland prairies, and broad alluviated valleys along the larger waterways (Leighton et al. 1948). The eastern portion of the expansion area is located in the Bottomlands Section of the Wabash Border Division and includes the floodplains of the Middle Fork of the Saline River (Schwegman 1970).

Soils of the study area vary according to parent material, vegetation present, climate, relief, and development time. Sources of soil material in this area include: (1) rocks weathered in place, (2) glacial drift, (3) outwash, (4) alluvium, and (5) loess (windblown deposits). Only one ice advance, the Illinoisan, reached Saline County, and deposits of glacial drift varied from a few inches on hilltops to 50-100 feet in old stream valleys (Smith et al. 1926). Upland soils are mainly loessial in origin, while bottomland soils have been derived from a mixture of thin loess, glacial till, alluvium, and outwash materials (Fehrenbacher et al. 1967). Generally, soils in this area of southern Illinois, developed under deciduous hardwood forests, are light-colored and of low inherent fertility. These soils are low in nitrogen, low to medium in potassium- and phosphorus-supplying power, and strongly to very strongly acid. Some fragipan or silt pan development is exhibited in lower horizons, which restricts air and water movement. Fertility, erosion, and drainage are major problems associated with soil types present on the Delta expansion area.

Soil Categories

Although the U. S. Soil Conservation Service (SCS) has not completed an updated soil survey for Saline County, 1974 field soil maps were available for the study area. Five general soil categories were identified: upland, bottomland, moderate slope, mixed, and terrace (Fig. 1). Approximate acreage of and major soil series in each category were tabulated based on SCS field soil maps (Table 4). Soil series interpretation sheets and Smith et al. (1926) provided information for the category descriptions.

Upland Soils (A)

Upland soils occur on gently to strongly sloping land (slope range 2-60 percent) that is now or was formerly covered with forest. These soils are slowly permeable and moderately well drained with a tendency to fragipan development. Due to the nature of the upland soil development, organic matter and nitrogen are naturally low, and the surface soil is medium to strongly acid. The surface soil, or A horizon, is a yellowish to brownish gray silt loam. The upper subsoil, or B horizon, is a tight yellow clay, while the C horizon, or lower subsoil, is a mottled silt loam.

Two soil associations, Ava-Frondorf-Hickory and Hosmer-Grantsburg-Zanesville, constitute the upland soils. Due to the steep topography, acidity, and low nitrogen and organic matter, these soils are not considered good for agricultural use, especially intertilled crops. SCS capability classes which range from moderate agricultural limitations for Ava to severe limitations for the Hickory series and low estimated crop yields (Table 5) indicate that upland soils are best suited for pasture, hayland, or woodland. Annual growth rates in properly managed tree stands showed white oak (*Quercus alba*), red oak (*Q. rubra*), and black oak (*Q. velutina*) suited to upland soils (Table 6).

Table 4. Approximate acreage of the major soil categories, Delta expansion area.[1]

Soil Category	Soil Series	Acres	Percent of Total
Upland (A)	Ava-Frondorf-Hickory Hosmer-Grantsburg-Zanesville	4,731.3	58.2
Bottomland (B)	Belknap-Bonnie	2,064.8	25.4
Moderate Slope (C)	Creal-Raccoon-Stoy	626.0	7.7
Mixed (D)	Wellston-Grantsburg-Sharon	439.0	5.4
Terrace (E)	Zipp-Patton-Hurst	268.3	3.3
	Total	8,129.4	100.0

---

[1] Calculated from 1974 field soil maps, U. S. Dept. of Agriculture Soil Conservation Service, Saline County, Illinois.

Table 5. Capability class and estimated crop yields of major soils present on the Delta expansion area.[1]

Soil Series	Slope Range (%)	Erosion Condition	Capability Class and Subclass[2]	Corn (bu/ acre)	Soybeans (bu/ acre)	Wheat (bu/ acre)	Oats (bu/ acre)	Legumes Grass (tons)	Pasture (AUD)[3]
Upland (A)									
Ava	2-18	Slight-severely eroded	IIe-IVe	60-90	0-30	28-40	--*	2.8-3.8	140-190
Frondorf	7-45	Slight-severely eroded	--**	--	--	--	--	2.8	150
Hickory	7-60	Slight-severely eroded	IIIe-VIIe	0-90	0-32	0-40	0-55	3.5-4.0	175-200
Hosmer	2-18	Slight-severely eroded	IIe-IVe	0-85	0-32	25-40	--	3.2-4.0	170-200
Grantsburg	2-12	Eroded-severely eroded	IIe-IVe	50-70	0-25	25-35	--	2.5-3.2	125-160
Zanesville	7-18	Eroded-severely eroded	--	0-75	0-30	0-35	--	3.0-3.5	126-170
Bottomland (B)									
Belknap	0-2	Uneroded	IIw	105	38	48	--	4.5	225
Bonnie	0-2	Uneroded	IIIw	90	32	40	--	3.8	190

---

[1] Data from soil series interpretation sheets, U. S. Dept. of Agriculture Soil Conservation Service.

[2] Capability class indicates the degree of hazard or limitations for the use of the soil for agriculture and the nature of soil limitation. Limitations in use and risk of soil damage increase progressively from Class I (lowest risk and fewest limits) to Class VIII (greatest risk and most limits).

[3] AUD = animal unit days.

*This crop not grown or not suited to this soil type.

**Capability classes have not been determined for series.

Table 5. Concluded.

Soil Series	Slope Range (%)	Erosion Condition	Capability Class and Subclass	Corn (bu/ acre)	Soybeans (bu/ acre)	Wheat (bu/ acre)	Oats (bu/ acre)	Legumes Grass (tons)	Pasture (AUD)
Moderate Slope (C)									
Creal	1-5	Slight	IIw	95	32	44	--	3.9	195
Raccoon	0-2	Slight	--	90	32	40	54	3.8	125
Stoy	0-7	Uneroded-eroded	IIw-IIe	90-100	32-35	40-45	--	4.0-4.2	200-210
Mixed (D)									
Sharon	0-2	Uneroded	I	115	40	30	70	4.8	240
Wellston	0-35	Uneroded-severely eroded	I-VIe	0-110	0-38	0-45	0-70	3.5-4.5	180-225
Terrace (E)									
Zipp	0-2	Uneroded	--	100-105	35-38	35-38	--	4.0	174-180
Patton	0-2	Uneroded	IIw	125	45	50	--	5.0	250
Hurst	0-6	Slight	IIIw-IIIe	73-76	28-29	37-39	--	3.3	165

Table 6. Estimated annual growth rate in tree stands with proper management by soil series.[1,2]

Soil Series	Growth in Board Feet Per Acre Black oak Red oak Post oak	Yellow poplar White oak Red oak Black oak	Oaks, Sweetgum, Ash, Sycamore, Maple, Cottonwood	Shortleaf pine Loblolly pine
Upland (A)				
Ava	--	500	--	Good
Hickory	--	250	--	Moderate-good
Hosmer	--	500	--	Good
Grantsburg	--	450	--	Good
Bottomland (B)				
Belknap	--	--	500-600	--
Bonnie	--	--	450	--
Moderate Slope (C)				
Creal	--	300	--	Good
Raccoon	200	--	--	--
Stoy	--	300	--	Good
Mixed (D)				
Sharon	--	--	700-800	--
Wellston	--	250	--	Fair
Terrace (E)				
Hurst	100-200	--	--	--
Patton	--	--	Good	--

---

[1] Fehrenbacher and Odell (1959).

[2] Proper management includes (1) harvesting mature, defective, and less desirable trees unless they provide cover for small, desirable species, and (2) protection from fire and grazing to prevent damage and to encourage growth of young trees.

Bottomland Soils (B)

Bottomland soils are formed in silt and clay sediment and occur along streams, in swamps, and in poorly drained low areas. The major agricultural problem in these soils is drainage. Natural fertility and acidity vary, but generally nitrogen and organic matter are low with slight to medium acidity. As a new deposit of soil is received annually or semiannually, bottomland soils have no well-defined soil horizons. The soil is usually a yellowish-gray silt loam, occasionally interspersed with sand.

Belknap-Bonnie is the major soil association in bottomlands. Due to flooding and to surface drainage problems, SCS capability classes indicate moderate to severe agricultural limitations. However, where these problems are corrected, estimated crop yields are competitive with the other soil categories of the study area (Table 5). Oaks (*Quercus* spp.), sweetgum (*Liquidambar styraciflua*), sycamore (*Platanus occidentalis*), cottonwood (*Populus* spp.), maples (*Acer* spp.), and ashes (*Fraxinus* spp.) are a few of the hardwood species adapted to bottomland soils (Table 6).

Moderate Slope (C)

Moderate slope soils (Creal-Raccoon-Stoy soil association) are found at the base of upland soils and at alluvial fans below drainageways. Formed in loess, silty outwash, or silt loam, these soils are somewhat poorly drained; however, as these areas are subject to less flooding than bottomland soils, soil development is more advanced, and nitrogen and organic matter levels are somewhat higher. If properly managed, moderate to good agricultural productivity may be achieved. Generally, growth rates of tree stands are lower for moderate slope soils, with red, white, black,

and post oak (*Quercus stellata*) representative species in this soil category (Table 6).

Mixed Soils (D)

Mixed soils, represented by the Sharon-Wellston-Grantsburg soil association, are restricted to the extreme western portion of the Delta area and indicate areas of high relief and rapid transition from upland to bottomland types. As compared to upland soils, these soils are less severely eroded and are more permeable. As a result, estimated crop yields are generally higher than for upland soils (Table 5). Erosion control is important for productive agricultural use. Oaks, sweetgum, sycamore, cottonwood, maple, and ash exhibit good productivity on Sharon soils, while yellow poplar (*Liriodendron tulipifera*), and white, red, and black oak are hardwood species in Wellston and Grantsburg soils (Table 6).

Terrace Soils (E)

The Zipp-Patton-Hurst soil association comprises the terrace soils of the study area. Terrace soils occur as benchland along stream valleys where silt is deposited by stream overflow and upland erosion. Although still low in nitrogen and organic matter, this gray silt loam is one of the best agricultural soils in Saline County. Generally, these soils are either neutral or slightly acid. Estimated crop yields indicate terrace soils are the most productive on the study area (Table 5). Removal of excess water and erosion control on sloping areas are usually needed to achieve optimum crop production. Post, red, and black oak show low productivity on the Hurst series, while oaks, sycamore, sweetgum, cottonwood, and maple are associated with the Patton series (Table 6).

The Harco Blacktop Road forms a transition zone for the five soil types. Upland soils (A) comprise about 56 percent of the study area, predominately west of the Harco Blacktop (Fig. 1). Mixed soils (D), comprising about [illegible] percent of the area, are found only west of the Blacktop. Pasture-old field and woodland are the dominant land-use types associated with these soils; some cropland is evident in the mixed soil category.

Moderate slope (C) and terrace (E) soils occur only east of the Harco Blacktop; most of the bottomland (B) acreage is also found there. Cropland, pasture-old field, and woodland are the major land-use types associated with moderate slope. Bottomland and terrace soils, comprising about 25 and 3 percent of the study area, respectively, are primarily utilized for grain production and cattle farming operations.

Soil Chemistry

A total of 104 soil samples were taken in the study area by S. H. Murdock, Consultant in Environmental Geology, and were analyzed by the AMAX Laboratory. The following tests were run: pH on a 1:1 mixture, nitrate-nitrogen (NO_3-N), Bray P_1 phosphorus (P), potassium (K), mercury (Hg), cadmium (Cd), lead (Pb), zinc (Zn), manganese (Mn), iron (Fe), and copper (Cu). As the first four tests are those usually recommended to determine soil fertility, discussion is limited to those topics. The pH, NO_3-N, P, and K values of soil from five different habitat types in the Delta expansion area appear in Table 7.

Acidity or alkalinity of the soil is often the factor limiting plant growth. Soil acidity affects plant growth by affecting the solubility of minerals so the minerals can not be absorbed by plant roots, and by limiting soil microorganisms. A pH of 4.0 or less is considered strongly acid and generally indicates lethal conditions to most plants (Limstrom 1964).

Table 7. A description of a soil sample from each of five habitat types in the Delta expansion area.[1]

Sample Location/Description	pH	NO_3-N (ppm)	P (ppm)	K* (ppm)
Forest--Upland				
NoCent of NW¼, SE¼, S 10, T 9S, R 5E. 20% slope				
0.0-0.5 Dark gray slightly moist silt	6.7	2.3	3.26	109
0.5-4.5 Brown-yellow to yellow brown, slightly moist	5.9	1.2	3.26	98
4.5-5.5 Redbrown to redyellow, moderately moist	6.8	1.8	4.12	83
5.5 Sandstone or shale				
Forest--Lowland				
NW¼, SW¼, SE¼, S 2, T 9S, R 5E. Floodplain				
0.0-1.0 Dark gray moderately moist silt	6.2	14.0	3.69	52
1.0-4.0 Light gray mottled with yellow, moderately moist silt	5.8	1.4	2.82	39
4.0-6.0 Yellow gray mottled with gray, very moist clay silt	5.3	1.2	4.12	46
Old Field-Pasture--Upland				
SW¼, SE¼, SW¼, S 10, T 9S, R 5E.				
0.0-0.5 Dark gray brown, moderately moist silt	6.6	1.2	1.09	101
0.5-1.5 Yellow brown moderately moist silt	5.5	1.2	0.65	72
1.5-5.0 Yellow gray with gray mottled, slightly moist clay silt	5.6	1.0	1.74	93
5.0-6.0 Gray with yellow mottled, gritty clay till, very moist	6.5	1.1	1.09	33
Old Field-Pasture--Lowland				
NW¼, NE¼, NW¼, S 7, T 9S, R 6E. Floodplain				
0.0-0.3 Dark gray dry silt	7.1	5.6	15.19	114
0.3-2.0 Gray mottled with yellow brown, dry clay silt	6.0	4.3	3.47	64
2.0-5.0 Gray mottled with yellow, slightly moist clayey silt	5.9	3.1	3.69	115
5.0-6.0 Yellow mottled with gray, moderately moist clayey silt	5.9	3.1	3.69	115

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[1] Personal communication, 28 January 1975, AMAX Coal Company, Indianapolis, Indiana.

*NO_3-N = nitrate-nitrogen; P = phosphorus; and K = potassium.

The optimum pH for agricultural crops ranges between 6.1 and 7.0 (Graffis et al. 1974); soil samples from the Delta expansion area range from pH 5.1 to 7.9 (average 6.2). The low pH occurred in the soil sample taken in a grassy roadcut west of the Harco Blacktop; the high of 7.9 was recorded in a soybean field located in the floodplain of the Middle Fork of the Saline River.

Throughout the United States, the surface soil of cultivated land contains an average of 1,500 ppm (0.15 percent) total nitrogen (Brady 1974). In southern Illinois, total nitrogen naturally available in the soil is approximately 750 ppm (0.075 percent) (personal communication, 27 May 1975, E. C. Varsa, Dept. of Plant and Soil Science, Southern Illinois University, Carbondale, Illinois). As tests for total nitrogen available to crops are generally inadequate, application of nitrogen fertilizer is based on the type of crop grown (Graffis et al. 1974). Tests by the AMAX Laboratory showed that NO_3-N levels range from 0.7 ppm to 24.0 ppm in the study area. The concentration of 0.7 ppm was found in an upland old field, a grassy roadcut with a 3 percent slope, and a roadcut with 8 percent slope; these sites were distributed throughout the study area. The site with the highest NO_3-N level was recorded for the floodplain field exhibiting the highest pH.

The average value of natural soil P throughout southern Illinois is 25 ppm (personal communication, 1975, E. C. Varsa). Saline and Williamson counties lie in the low P-supplying section of Illinois; a low P usually means drouthiness, acidity, and poor internal drainage restricting root penetration (Graffis et al. 1974). According to Graffis et al., P levels should be 40-50 ppm for favorable growth conditions. P values in the study

area range from 0.65 ppm in an upland forest and an upland old field to 30.16 ppm in two floodplain soybean fields.

Most of the study area lies within the low K-supplying region of the state (Graffis et al. 1974). Southern Illinois soils generally exhibit 130 ppm K (personal communication, 1975, E. C. Varsa); for agricultural purposes, 120-150 ppm K is recommended (Graffis et al. 1974). Throughout the study area, K ranges from 29 ppm in a lowland pasture to 332 ppm in a floodplain soybean field.

Although tests for organic matter were not conducted on the study area, the natural value of organic matter in southern Illinois is approximately 1.5 percent (personal communication, 1975, E. C. Varsa). The average value for the United States is 4 percent (Brady 1974); in contrast, organic matter naturally available in northern Illinois ranges from 4 to 7 percent (personal communication, 1975, E. C. Varsa).

PART III: LAND USE

METHODS AND MATERIALS

Land-use maps of the Delta expansion area were prepared for 1938, 1951-1952, and 1974 based on aerial photographs. The 1951-1952 map reflected a one year difference in aerial coverage of the Williamson and Saline County portions of the study area. U. S. Department of Agriculture (USDA) aerial photos of the study area for 1938 and 1951-1952 were obtained from Morris Library of Southern Illinois University-Carbondale. The 1974 aerial photos were available from the Southern Division Office of AMAX Coal Company. The standard scale of USDA 9- x 9-inch photos was 1:20,000. As this scale was used in base map preparation, photographic reduction of the larger 1974 photos (1:5,000) was required prior to base map preparation. With the aid of a stereoscope, land-use types were identified and delineated on photo prints. The base map was completed in black ink on frosted cellulose acetate at a scale approximating photo prints (1:20,000).

Acreages of each land-use type were calculated by the transparent dot grid system (Bryant 1943). A transparent grid was placed over the completed base maps, and the number of dots within each designated land-use type was counted. A 64 dot per square inch grid was utilized; each dot represented approximately 1 acre at the nominal photo scale of 1:20,000. The total acreage of the Delta expansion area was calculated from the original base map (1938), and acreage determinations for individual years were represented as portions of the total acreage. Use of the

standard unit acreage facilitated comparison of land-use changes which occurred during the 36-year period.

RESULTS AND DISCUSSION

Land-Use Types

Ten land-use types were identified and mapped on the Delta expansion area: cropland, pasture-old field, woodland, hedgerow, orchard, public road, railroad, buildings, surface-mined land, and water (Figs. 2, 3, and 4). This classification provided land-use types consistently recognized on aerial photos and reduced extensive ground verification necessary in more detailed land-use classification.

Cropland. Cropland included all cultivated acreage in row crops and small grains, as well as miscellaneous cultivated crops. On aerial photos, cropland was generally lighter in color and appeared stipled due to tillage. Usually tilled land, with or without standing crops, exhibited a row pattern of cultivation. Tilled land without standing crops appeared lighter in tone than vegetated areas. As identification of specific field crops usually requires a series of aerial photos from typical stages before, during, and after the growing season (Brunnschweiler 1957), specific crop identification was not attempted. Hayfields were not included in cropland due to difficulty in differentiation from the pasture-old field type.

Pasture-Old Field. This category included hayland, permanent pasture, fallow land, and abandoned cropland in various stages of old field development. This land-use type appeared mottled with small patches of light and dark areas; tone was darker than cropland. This tone-texture combination was indicative of small shrub and tree growth. More mature old field was separated from woodland by broken crown cover (less than 10 percent) and

low level tree and woody vegetation. Animal trails were sometimes present, an indication of pasture land.

Woodland. All areas having tree crown coverage estimated greater than 10 percent were categorized woodland. Woodland acreage was easily distinguished by its dark to black shade in aerial photos. Irregular texture and shadows were apparent in open stands or along edges of woodlands.

Hedgerow. This type was defined as any strip of woody vegetation approximately 100 feet or less in width. The majority of hedgerow occurred along waterways and field borders. Photo resolution was adequate to recognize these strips of vegetation and establish proper identification.

Orchard. As orchards are laid out in orderly grid fashion, this land-use type was easily distinguished on the aerial photos. Apple and peach orchards are relatively common in southern Illinois.

Public Roads, Railroads, and Buildings. All three categories were readily apparent on aerial photos. For the purpose of this study, public road and railroad acreage included the maintained portion of the right-of-way. Building acreages included buildings proper and their adjacent grounds.

Surface-mined Land. This type included the acreage distinctly recognizable as having been mined. Reclaimed surface-mined land planted to trees or naturally revegetated were difficult to distinguish from other land-use types. This difficulty probably resulted in placement of surface-mined land in woodland or pasture-old field land-use categories.

Water. Ponds, lakes, and other areas that appeared to have permanent water were included in this type. Streams were not included due to overshading by streambank tree canopy.

Land-Use Trends

Acreage and percent of each land-use type in the Delta expansion area were tabulated (Table 8). Basically, the Delta expansion area remained a rural agricultural area from 1938 to 1974. Cropland, pasture-old field, and woodland were the major land-use types in terms of acreage, and together comprised almost 92 percent of the total acreage over the 36-year period. The acreage of the seven remaining types (hedgerow, orchards, public roads, railroad, buildings, surface-mined land, and water) remained relatively stable throughout the years at approximately 8 percent.

Influences of Agriculture

The Delta expansion area is located in the south-central portion of the general farming region of Illinois (Ross and Case 1956). Historically, farming in this area was conducted on a small scale, with low capital investment and small farm income. The predominate light-colored, upland soils were generally less productive than the dark-colored prairie soils of northern and central Illinois. To maintain agricultural productivity, light-colored soils usually required more intensive conservation treatment including fertilization, erosion and flood control, and careful land management.

From 1930 to 1950, depression and wartime conditions accelerated agricultural change throughout Illinois resulting in rising price levels related to farm property, farm products, and cost of operations (Ross and Case 1956). Mechanization and technological advancement also added to the

Table 8. Acres and percent of each land use type, Delta expansion area, 1938, 1951-1952, and 1974.

	1938		1951-1952		1974	
Land Use Type	Acres	Percent	Acres	Percent	Acres	Percent
Cropland	2,657.2	32.7	3,630.9	44.7	3,110.7	38.2
Pasture-Old Field	3,260.9	40.1	2,192.1	27.0	1,822.3	22.4
Woodland	1,610.6	19.8	1,657.0	20.4	2,511.4	30.9
Hedgerow	198.2	2.4	282.4	3.5	308.0	3.8
Orchard	154.4	1.9	44.0	0.5	4.5	0.1
Public Road	20.9	0.3	20.0	0.2	128.6	1.6
Railroad	13.9	0.2	33.0	0.4	33.0	0.4
Buildings	199.3	2.5	170.9	2.1	112.7	1.4
Surface-mined Land	--	--	71.0	0.9	49.5	0.6
Water	13.9	0.2	28.0	0.3	48.6	0.6
Total	8,129.3	100.1	8,129.3	100.0	8,129.3	100.0

rapid change witnessed in farming operations. The SCS was established at this time, and payment of subsidies was initiated for certain conservation practices under direction of federal agencies. Throughout the United States, soil-building materials such as limestone, phosphate, and fertilizers were applied at increasing rates. Erosion control and improved rotational systems were widely adopted. Improved varieties of seed corn, soybeans, small grains, and minor crops were developed. Generally in Illinois, these factors appeared to have affected quality rather than quantity in agricultural acreages since 1930 (Ross and Case 1956).

In southern Illinois, advancements in agricultural technology allowed for increased emphasis on grain crop production. Prior to 1930, old cultivation practices had reduced one-third of Saline County to submarginal agricultural land (Smith et al. 1926). However, between 1930 and 1964, acreage in major grain crops (corn, soybeans, and wheat) increased almost 45 percent in Saline County, while total farm acreage continued to decline (Moats et al. 1968). On the Delta expansion area cropland acreage increased by 6 percent from 1938 to 1974.

Reduction in pasture-old field acreage from 1938 to 1974 was attributable to general declines in production of livestock, livestock products, and hay acreage in this area of southern Illinois. In 1950, livestock and livestock products generated almost 56 percent of the total farm income in Saline County (Moats et al. 1968). In 1966, sale of livestock and its products declined to 30 percent of the total, suggesting increased reliance on cash grain operations for farm income. The total hay acreage in Saline County declined from 20,200 acres in 1938 to 10,600 acres in 1966 (Moats et al. 1968). Declining livestock operations and hay production resulted in corresponding loss of pasture and hayland acreages on the Delta

expansion area from 1938 to 1974. Subsequent increase in woodland acreage has resulted in a net decline of agricultural-related acreage (cropland and pasture) on the study area from 5,917 acres in 1938 to 4,932 acres in 1974 (Table 8). As the mixed hardwood forests of the study area were generally ungrazed and unharvested, the increase in woodland acreage suggested limitations, probably financial, associated with productive agricultural utilization of much of the Delta expansion area.

With the overall increase in cropland acreage between 1938 and 1974, hedgerow acreage also increased. The greatest increase (1.1 percent) in hedgerows occurred between 1938 and 1951-1952, which corresponded to the largest increase (12.0 percent) in cropland (Table 8). The small, patchwork nature of the majority of agricultural fields in the study area served to increase amounts of hedgerow in the form of field border.

Influences of Successional Patterns

The changes in cropland, pasture-old field, and woodland acreages from 1938 to 1974 were also related to successional patterns in this area of southern Illinois. Approximately 100 years ago, woodland represented the dominant vegetational community in southern Illinois (Voigt and Mohlenbrock 1964). Large amounts of woodland were subsequently cleared for cropping, and soil structure was seriously altered. As cropland was abandoned or fallowed, a progression of transitional, vegetational stages (seres) eventually led to a woodland stage once again. The pasture-old field type represented the transitional stage between cropland and woodland. Approximately 10 to 30 years are required for development of woodland from abandoned cropland in southern Illinois (Voigt and Mohlenbrock 1964).

Although agriculture remained the dominant land use on the Delta expansion area from 1938 to 1974, total agricultural-related acreage declined

(Table 9). Changes in woodland and cropland acreage from 1938 to 1974 suggested that, initially, more pasture-old field acreage was placed in intensive crop production (cash grain) and, subsequently, as crop production proved unsuccessful, was allowed to revert to old field and then to woodland.

Other Influences

Orchard acreage decreased sharply from 1.9 percent in 1938 to 0.1 percent in 1974 (Table 8). Severe freezes in the winters of 1949-1950 and 1950-1951 and increased competition from the larger fruit producers were responsible for the decline of orchards in this area of southern Illinois (Ross and Case 1956).

Trends in public road and railroad acreage appeared related to increased development of transportation systems during this period. However, railroads stabilized around the 1950's, while public roads increased 8-fold by 1974 (Table 8). The majority of public roads on the study area are unimproved secondary roadways.

Declining building acreage (2.5 percent in 1938 to 1.4 percent in 1974) reflected population declines in this area of southern Illinois (Table 8). From 1930 to 1970, the population of Brushy Township, Saline County, declined from 1,892 to 868 (Moats et al. 1968).

Water and surface-mined land each comprised less than 1 percent of the study area in all periods examined (Table 8). Surface-mined land was not present on the area in 1938. The decline in surface-mined land acreage from 1951-1952 to 1974 was probably due to revegetation during this period and to placement of former stripped land in the pasture-old field type. Construction of several small farm ponds was responsible for the 0.4 percent increase in water acreage on the study area from 1938 to 1974 (Table 8).

Table 9. Net change in acreage of each land use type, 1938 to 1951-1952, and 1951-1952 to 1974, Delta expansion area.

Land Use Type	Net Acreage Change 1938 to 1951-1952	 1951-1952 to 1974
Cropland	+973.7	-520.2
Pasture-Old Field	-1,068.8	-369.8
Woodland	+46.4	+854.4
Hedgerow	+84.2	+25.6
Orchard	-110.4	-39.5
Public Road	-0.9	+108.6
Railroad	+19.1	0.0
Buildings	-28.4	-58.2
Surface-mined Land	+71.0	-21.5
Water	+14.1	+20.6

Recreational Use of the Study Area

Fifty-seven families resident to the study area were interviewed regarding their recreational use of the study area. The main recreational activities were fishing, hunting, and picnicking.

Fishing was the most popular sport in the study area; 64.9 percent of the families participated. An estimated 1,033 fishing trips were made in 1974; most of these trips were to small farm ponds on the study area. Major species caught were bluegill, bass, catfish, and crappie.

Thirty-six families (63.2 percent) hunted on the study area; 18 (31.6 percent) did not hunt. Three families (5.3 percent) hunted outside of the study area. Bobwhite quail was the most popular game bird with 17 families harvesting 307 birds in the 1974-1975 season (Table 10). Rabbits and squirrels were the most hunted game mammals. Twenty-six families harvested 193 rabbits in 146 trips; 15 families bagged 203 squirrels in 161 trips (Table 10). Although very little trapping took place in the study area, raccoons, fox, and coyotes were hunted with dogs. It appeared that capturing one of the latter three species was of secondary importance to the running of the dogs.

An additional 138 hunters from other areas utilized the study area, mostly for bird hunting. Residents of the area estimated 106 trips were made by these hunters. No estimates of their success were available. These outside hunters came from Harrisburg, Galatia, Harco, and Sesser, or were local neighbors.

Other outdoor, nonconsumptive activities were popular, particularly picnicking and hiking. The number and percent of families participating in each activity is given in Table 11. Estimates of non-residents participating in these activities were not available.

Table 10. Game birds, game mammals, and furbearers hunted in the Delta expansion area, 1974-1975 season.

Species Hunted	Total Families Hunting	Estimated Total Trips Afield	Estimated Total Harvest
Game Birds			
Bobwhite quail	17	142	307
Mourning dove	3	28	28
Woodcock	1	20	5
Crow	0	0	0
Ducks	4	21	10
Geese	2	20	0
Coots	1	20	30
Game Mammals			
Rabbit	26	146	193
Squirrel	15	161	203
White-tailed deer	8	26	13
Woodchuck	2	7	5
Furbearers			
Raccoon	11	70	28
Fox	3	50	1
Coyote	2	50	0

Table 11. Number and percent of resident families participating in wildlife-oriented, nonconsumptive recreation during 1974, Delta expansion area.

Activity	No. of Families Participating	Percent of Total
Picnicking	27	47.4
Hiking	17	29.8
Off-road vehicle riding	13	22.8
Birdwatching	8	14.0
Archery	5	8.8
Photography	4	7.0
Bicycle riding	1	1.8
Horseback riding	1	1.8
Running dogs	1	1.8

PART IV: TERRESTRIAL ENVIRONMENT

METHODS AND MATERIALS

Vegetation Sampling

Fifty sites in the Delta expansion area were chosen with the aid of aerial photographs, topographic maps, soil maps, and on-site observations so as to adequately represent all habitat types in all successional stages (Appendix A, Fig. 5). These sites were placed randomly throughout the study area. A 500-foot transect was established at each site for sampling purposes.

Three vegetational classes were sampled: (1) Class 1 vegetation (tree layer) included woody plants with a basal area greater than 2.5 inches DBH (diameter breast height); (2) Class 2 vegetation (shrub layer) included woody plants with DBH 1 inch to 2.5 inches; and (3) Class 3 vegetation (herbaceous layer) included herbs, grasses, and vines. Woody plants less than 1 inch DBH were included in Class 3 vegetation as at this growth size they constitute part of the ground cover. Sampling points for terrestrial vegetation were established at 100-foot intervals along the transect lines. At each sampling point, Class 1 and 2 vegetation were sampled in 0.1- and 0.01-acre circular plots, respectively (Lindsey et al. 1958). Density (trees/acre) and dominance (total basal area) values were computed for Class 1 vegetation; only density values were calculated for Class 2 vegetation (Appendix B). Class 3 vegetation was sampled in 0.001-acre circular plots; cover was estimated by the Braun-Blanquet (1932) method.

Aquatic vegetation was defined as that living within or growing from a substrate which was normally under water. This vegetation was sampled

using the terrestrial vegetation methods along transects established parallel to the shores of ponds and streams.

Mammal Sampling

Trapping stations for small mammals were placed every 25 feet along the vegetation transects with two Museum Special snap traps and one Victor snap trap, baited with rolled oats and peanut butter, per station. Traps were run for two consecutive nights during each sampling season (winter, spring, and summer). Small mammals captured were placed in plastic bags and frozen. Species captured, number, date, habitat type, and transect number were recorded.

Surveys of ponds and of streambanks (1/4 mile up- and downstream of the hydrological sampling sites, Fig. 6) for active "houses" and bank dens were conducted to assess the relative abundance of muskrats and beavers. Squirrel abundance, expressed as squirrels per acre, was determined by utilizing the "time area count" method in forest habitat located along the sampling transects (Uhlig 1956). Abundance or presence of other mammals was evaluated by observation of sign and/or dens throughout all habitat types, with emphasis on areas adjacent to transect lines. A winter survey of abandoned buildings and other suitable shelters was conducted to determine their utilization by hibernating bats.

Bird Sampling

The strip census method of Forbes-Gross (1907 in Graber and Graber 1963) was used to census bird populations during winter, spring, and early summer. The census routes were along the 500-foot vegetation transects within specific habitat types. In wooded areas, species and number of all birds within or flying over a 100-foot-wide belt were recorded. Each census

in wooded areas equalled 50,000 square feet. In open areas, the species and number of all birds within or flying over a 150-foot-wide belt were recorded. Each census route equalled 75,000 square feet. A walking pace of 50 minutes per mile was maintained on all census routes. Censuses were conducted from 1/2 hour after sunrise until 11 a.m. Each census route was traveled two or three times each, varying with season and habitat type (Giles 1971). From the census data, the number of birds per acre was calculated utilizing the following formulae:

(1) Square feet of habitat type = Length (feet) of each transect X Number of times each transect censused X Width censused

$$(2)\ \text{Number of acres sampled} = \frac{\text{Square feet of each habitat type}}{\text{Square feet/acre}}$$

$$(3)\ \text{Birds/acre} = \frac{\text{Number of birds in each habitat type}}{\text{Number of acres sampled of each habitat type}}$$

Bimonthly raptor surveys were conducted along an established 10-mile route over the roads of the study area. Species observed, number, and habitat type were recorded.

Amphibian and Reptile Sampling

Collection and observation of amphibians and reptiles were conducted in all habitat types adjacent to the vegetation transects. Special emphasis was placed on preferred aquatic habitats and in riparian habitats adjacent to the hydrological sampling sites. Specimens collected were identified and preserved in 10 percent formalin. Roads were driven after spring rains to collect those amphibians and reptiles moving between ponds and ditches. Amphibians and reptiles found dead along roads were examined and identified.

Macroinvertebrate Sampling

All invertebrates were sampled in the spring and summer. Organisms collected were preserved in 10 percent formalin for identification and counting.

For terrestrial macroinvertebrates, two samples were taken from each habitat type. Each sample included net sweep (100 strokes per sample) and the collection of soil and organic matter (from two foot-square plots). The latter samples were placed in a Berlese separator.

RESULTS AND DISCUSSION

Density, total basal area, and importance value of Class 1 vegetation are given in Appendix C; density of Class 2 vegetation is listed in Appendix D. Appendix E lists all plant species found on the area and their cover value as Class 3 vegetation. Total density and basal area of each habitat type are given in Table 12.

Nine habitat types were delineated in the Delta expansion area: creeks and streams, creek forest, floodplain forest, lowland old field, pond and pond bank, upland forest, upland old field, hedgerow, and anthropogenic lands. Although it was not possible to separate and map the nine habitat types on the basis of aerial photographs, in 1974 total forest comprised about 2,511 acres (30.9 percent) of the Delta expansion area, total old field included approximately 1,822 acres (22.4 percent), ponds about 47 acres (0.6 percent), hedgerow 308 acres (3.8 percent), and anthropogenic lands about 3,440 acres (42.3 percent). Within these habitats, fieldwork yielded a total of 411 plant taxa representing 88 families. Three rare plants were located on the study area. Mohlenbrock and Voigt (1959) recorded 1,599 plant taxa (1,518 species) representing 143 families

Table 12. Density (trees/acre) and total basal area of all Class 1 vegetation in each habitat type, Delta expansion area.

Habitat Type	Density (Trees/Acre)	Total Basal Area
Creek Forest	282.8	83.4
Floodplain Forest	400.0	89.5
Lowland Old Field	15.3	3.7
Ponds and Pond Banks	126.6	21.2
Upland Forest	211.4	69.9
Upland Old Field	29.0	4.1
Hedgerow	148.8	37.0

in the southern 12 counties of Illinois. A total of 399 taxa in 91 families was documented in Hamilton County, located directly north of Saline County (Tracy 1967); Keser (1959) found 428 plant species and varieties at the Stone Face Recreation Area, Saline County.

As a result of fieldwork and literature surveys, a total of 354 animal species and subspecies within 81 families were shown to occur or might occur in the Delta expansion area (Appendix F). Forty-four species of mammals in 15 families, 252 species of birds in 48 families (17 orders), and 58 species of amphibians and reptiles in 18 families were expected to occur on the basis of range and habitat availability.

Fifty-nine species of wild mammals are known to occur in Illinois; of these, 36 are distributed state-wide (Hoffmeister and Mohr 1957). During the course of this study, out of the 44 mammals expected, the presence of 29 was verified. Although not observed, five mammals considered rare or endangered in the State of Illinois were included in the total expected.

Small mammal trapping was utilized to provide an index to the faunal diversity of the designated habitat types, as well as to provide an index of relative abundance of small mammals in each habitat. Trapping effort included 16,380 Trap-Nights (TN) (Table 13): 5,520 TN in winter, 5,220 TN in spring, and 5,640 TN in summer. Trapping success, reported as captures per 100 TN, averaged 4.4 for all seasons: 4.0 captures/100 TN in winter, 4.9 in spring, and 4.3 in summer (Table 13). Major seasonal variation was evident only in floodplain forest habitat where flooding occurred periodically. Trapping yielded 723 specimens representing 11 species from 5 families. The overall small mammal relative abundance and species composition for the entire study area, as well as for the individual habitats, were typical of the southern Illinois region (Layne 1958, Swayne

Table 13. Total trap-nights (TN) and success (captures/100 TN) by habitat type and by season, Delta expansion area, 1975.

Habitat Type	Total Trap-Nights	Total Trapping Success (captures/100 TN)	Seasonal Trapping Success Winter	Spring	Summer
Creek Forest	2,400	5.6	6.2	6.1	4.5
Floodplain Forest	2,100	3.8	3.3	5.9	2.7
Lowland Old Field	2,520	5.1	4.2	3.7	7.4
Pond Edge	1,080	2.9	1.4	2.5	4.7
Upland Forest	3,960	3.2	2.3	4.2	3.2
Upland Old Field	2,160	4.6	4.9	5.1	3.8
Hedgerow	2,160	5.8	6.0	6.5	4.9

1949). One noteable exception was the southern bog lemming; usually considered uncommon in the State (Hoffmeister and Mohr 1957), this rodent was locally abundant on the study area.

Graber and Graber (1963) recorded 132 bird species in 17 southern Illinois counties; 68 species were observed in winter and 116 in summer. On the Delta expansion area, 128 bird species were observed; of these, 13 were rare or endangered. Fifty-four species were observed on the area in winter, 111 in spring, and 70 in summer. Although winter had the fewest number of species, this season had the greatest number of individuals per acre (Table 14). These high numbers resulted from large roosting and feeding flocks of the common grackle; flocks of 400 or more individuals were frequently encountered. Lowland old field, upland forest, upland old field, and hedgerows showed great increases in utilization by birds in winter (Table 14). In spring, species diversity is traditionally high as many winter residents are still present, as well as permanent residents, migratory species, and early summer residents. The 70 species recorded in summer represent the breeding residents of the study area. Summer census figures indicated a higher number of birds per acre in open habitats, which included edge zones, than in forest habitats (Table 14). This may be a result of the better visibility afforded the observer in the more open areas.

Based on the range of the species in Illinois and the availability of suitable habitat, 58 species and subspecies of amphibians and reptiles were expected to occur on the study area; of these, four species were considered rare or endangered. During fieldwork, the presence of 31 species was verified.

Table 7. Concluded.

Sample Location/Description	pH	NO_3-N (ppm)	P (ppm)	K (ppm)
Cultivated Field				
SW¼, SW¼, SE¼, S 1, T 9S, R 5E. Soybeans in floodplain				
0.0-1.0 Gray brown, moderately moist silt	6.9	7.0	3.26	44
1.0-4.0 Gray brown mottled with gray, moderately moist to wet siltclay	5.6	1.9	1.74	37
4.0-6.0 Yellow brown with gray, moderately wet clayey silt	5.6	1.0	3.26	36

Table 14. Number of birds per acre in seven habitat types by season, Delta expansion area, 1975.

Habitat Type	Number of Acres Censused*	Number of Birds Per Acre		
		Winter	Spring	Summer
Creek Forest	16.1	6.4	6.9	4.2
Floodplain Forest	24.2	4.6	6.3	5.0
Lowland Old Field	34.5	10.9	3.3	4.5
Pond Edge	11.5	1.7	4.3	5.2
Upland Forest	33.7	18.7	4.8	3.4
Upland Old Field	27.6	11.0	3.1	2.8
Hedgerow	39.6	9.8	4.4	6.8

*This number represents the average number of acres censused each season.

Spring and summer collecting yielded two major groups or classes of macroinvertebrates in the habitats of the Delta expansion area: Class Arachnida (spiders and mites) and Class Insecta (insects) (Appendix G). The most abundant insects were the beetles (Order Coleoptera) represented by 125 genera in 30 families, the flies (Order Diptera) with 141 genera in 38 families, and the bees and wasps (Order Hymenoptera) with 58 genera and species in 27 families. The Orders Collembola (springtails), Psocoptera (book lice), and Lepidoptera (butterflies) were not identified past the family group; the thrips (Order Thysanoptera) were identified only to Order. The terrestrial macroinvertebrates found were those typically associated with these habitats in southern Illinois (personal communication, 1975, J. A. Beatty, Dept. of Zoology, Southern Illinois University, Carbondale, Illinois). A few additional groups may be discovered by specialized sampling techniques. Generally, the cosmopolitan nature of most invertebrates prevents any significant characterization of habitats based on the invertebrate fauna.

A. Habitats of the Delta Expansion Area

Habitat refers to the place where an organism lives, or the place one would go to find it. For plants, habitats are usually defined in terms of the physical environment, such as swamp or blufftop. Plant-eating animals, or herbivores, are attracted to certain plants as a food source. The carnivores, in turn, are often found in association with these plants because of the prey species living there. As a result, animal habitats tend to be defined in terms of the vegetation present. Generally, those plants and animals capable of adapting to a variety of environmental conditions, or habitats are the most abundant. Species which are extremely habitat

specific tend to become rare, localized, or even extinct as environmental conditions are altered.

The following section describes the habitat types distinguished in the Delta expansion area. Each habitat has been defined and described in terms of vegetative composition. The most important, or dominant, species of the three vegetation layers in each habitat type were determined from the values computed in Appendices C, D, and E. Tree species with the highest importance values were considered dominant; those shrubs with the greatest density were most important. Herbaceous species exhibiting the greatest amount of ground cover were placed in the understory description of each habitat type. Importance values of trees (Class 1 vegetation) serve as convenient indicators of soil and water conditions by summarizing the numbers (density) and the size (dominance) of the trees present.

A summary of the most common mammals, birds, amphibians, reptiles, and macroinvertebrates associated with each habitat follows the vegetation descriptions. These summaries of the animal composition were not meant to include every species that could occur there, but rather to provide an overview of the biological composition of each habitat; a complete list of all animal species which may occur in each habitat appears in Appendix F. Habitat requirements of the rare or endangered species which may occur in each habitat are further detailed in section B.

Creek and Stream Habitat

Creek and stream habitat was strictly aquatic and included permanent streams, as well as intermittent tributaries. Many of these areas had low, often temporary water levels which fluctuated according to local precipitation and to position within the larger drainage system.

Vegetation

Aquatic vegetation was not abundant in this habitat. In selected areas, silt deposits restricted water flow sufficiently to allow small pondweed (Potamogenton pusillus) to become established.

Mammals

Number of species which may occur: 3
Rare or endangered species which may occur: None
Species commonly observed or typically associated: Muskrat, mink, raccoon

Most creeks and streams of the study area were considered inferior habitat for water-associated mammals due to pollution, fluctuating water levels, and the lack of floating and emergent vegetation. Only one observation of muskrat sign was recorded. Although not totally dependent upon this habitat for food, mink and raccoon frequently forage along creeks and streams for aquatic invertebrates.

Birds

Number of species which may occur: 36
Rare or endangered species which may occur: Ruddy duck, hooded merganser (Double-crested cormorant, snowy egret, bald eagle, osprey, peregrine falcon, and common tern--unusual occurrence)
Species commonly observed or typically associated: Belted kingfisher, rough-winged swallow, barn swallow, cliff swallow

Although many bird species were observed flying over creeks and streams or in the creek forest, relatively few were associated directly with this aquatic habitat. Waders, waterfowl, and shorebirds that utilize the mud and sand flats of streams were uncommon in this area. The belted kingfisher, and the rough-winged, barn, and cliff swallows may use the mud banks of some larger tributaries of Bankston Fork and Brushy Creek for nesting. Creeks and streams supply water and aquatic insects for birds associated with nearby forests and fields.

Amphibians and Reptiles

Number of species which may occur: 30

Rare or endangered species which may occur: Eastern wood frog, mud turtle

Species commonly observed or typically associated: Mud puppy, Blanchard's cricket frog, upland chorus frog, bullfrog, southern leopard frog, common snapping turtle, midland painted turtle, red-eared turtle, eastern spiny softshell turtle, midland water snake

Although not frequently observed, the mud puppy is a common inhabitant of large creeks and streams where submerged debris provide ideal cover and egg-laying habitat. Blanchard's cricket frog, upland chorus frog, bullfrogs, and southern leopard frogs were commonly seen among creekside vegetation. Slack-water areas of the larger creeks and streams provide suitable breeding sites for these frogs. The common snapping turtle and red-eared turtle were observed along quiet sections of the larger creeks of the study area, while the eastern spiny softshell turtle and midland water snake more frequently utilized the fast-running creeks and streams.

Macroinvertebrates

The macroinvertebrates of the creeks and streams of the Delta expansion area will be discussed in detail in Part V: Aquatic Environment.

Creek Forest Habitat

A forest was defined as any area more than 100 feet in width having woody vegetation greater than 10 feet in height. Creek forests occurred adjacent to streams, at lower slope levels, and in protected ravines.

Vegetation

Creek forest habitat exhibited greater vegetative diversity than any other forest type. A total of 148 species representing 52 familes was recorded in this habitat. Seasonal inundation and rapid soil drainage

provided an intermediate moisture condition between upland and floodplain habitats, which allowed plant species associated with both upland and floodplain forests, as well as other species, to become established in creek forests.

Creek forest vegetation exhibited well-developed tree, shrub, and herbaceous, or understory, layers. The dominant trees in this habitat included ashes (*Fraxinus* spp.), American elm (*Ulmus americana*), black cherry (*Prunus serotina*), river birch (*Betula nigra*), and sycamore (*Platanus occidentalis*). Other important associated tree species were red maple (*Acer rubrum*), black oak (*Quercus velutina*), and pin oak (*Q. palustris*).

The most important species found in the shrub layer were ashes, sassafras (*Sassafras albidum*), American elm, and slippery elm (*Ulmus rubra*). In the understory, poison ivy (*Rhus radicans*), buckbrush (*Symphoricarpos orbiculatus*), Virginia creeper (*Parthenocissus quinquefolia*), spotted touch-me-not (*Impatiens biflora*), and white avens (*Geum canadense*) were the most important species.

Mammals

Number of species which may occur: 32
Rare or endangered species which may occur: Southeastern shrew, gray bat, Indiana bat, bobcat
Species commonly observed or typically associated: Opossum, big brown bat, eastern fox squirrel, flying squirrel, raccoon, mink, striped skunk, woodchuck

Vegetative diversity and the presence of water contributed to the importance of this habitat type for riparian (bank-dwelling) species such as raccoon, mink, and striped skunk. The abundant dead trees and logs were utilized for den sites; hollow trees were also important for eastern fox squirrels and tree-roosting bats. An average of 1.3 active

woodchuck dens occurred along or 100 feet on either side of 57 percent of the creek forest transects.

Indicative of the vegetative diversity, small mammal trapping success was second highest in creek forests (5.6 captures/100 TN). Captures included eight species, with white-footed mice and deer mice accounting for about 57 and 31 percent, respectively, of the total catch (Table 15). The somewhat uncommon (less than 0.1 captures/100 TN) meadow jumping mouse and one unusual specimen, a partial albino short-tailed shrew, were also recorded in this habitat.

Birds

Number of species which may occur: 80
Rare or endangered species which may occur: Sharp-shinned hawk, red-shouldered hawk, Nashville warbler, veery (Bald eagle--unusual occurrence)
Species commonly observed or typically associated: Blackbirds, common grackle, cardinal, tufted titmouse, woodpeckers, blue jay, white-crowned sparrow, white-throated sparrow, barred owl

Although only 19 species were observed during winter, the number increased to 36 during the spring census in creek forests. Twenty-six species were sighted during summer. This habitat provided heavy brushy cover, water, and food, especially moist-ground insects and larvae. Flocks of blackbirds and grackles were abundant in winter; the cardinal, tufted titmouse, and woodpeckers were also common.

Moist, brushy edge cover made this habitat particularly attractive to migratory wood warblers, vireos, and thrushes. The rare veery was observed here. Northward-migrating winter residents of this area, such as the white-crowned sparrow, the white-throated sparrow, and kinglets, were frequently seen in small flocks during spring.

Table 15. Species composition of small mammals captured in seven habitats of the Delta expansion area, 1975.

Habitat	Total Captured* #IND	Total Captured* #SP	White-footed Mouse #	White-footed Mouse %	Deer Mouse #	Deer Mouse %	Prairie Vole #	Prairie Vole %	Southern Bog Lemming #	Southern Bog Lemming %	Pine Vole #	Pine Vole %	House Mouse #	House Mouse %	Short-tailed Shrew #	Short-tailed Shrew %	Least Shrew #	Least Shrew %	Other #	Other %
Creek Forest	134	8	76	56.7	42	31.3					3	2.2	1	0.8	9	6.7	1	0.8	2[1,2]	1.5
Floodplain Forest	79	4	66	83.5	7	8.9							1	1.3	5	6.3				
Lowland Old Field	128	9	21	16.4	30	23.4	23	18.0	12	9.4	6	4.7	7	5.5	8	6.3	20	15.6	1[1]	0.8
Pond Edge	31	6	10	32.3	14	45.2	2	6.4	1	3.2					3	9.7	1	3.2		
Upland Forest	127	6	84	66.1	17	13.4					6	4.7			18	14.2			2[2,3]	1.6
Upland Old Field	99	8	12	12.1	43	43.4	24	24.2	3	3.0	3	3.0	1	1.0	7	7.1	6	6.1		
Hedgerow	125	9	41	32.8	39	31.2	3	2.4	1	0.8	1	0.8	18	14.4	15	12.0	6	4.8	1[1]	0.8
Total	723		310	42.9	192	26.6	52	7.2	17	2.4	19	2.6	28	3.9	65	9.0	34	4.7	6	0.8

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[*] IND = individual animals and SP = species.
[1] Meadow jumping mouse.
[2] Eastern chipmunk.
[3] Southern flying squirrel.

The cardinal was the most abundant breeding summer bird, accounting for nearly 20 percent of summer observations. The gray catbird, blue jay, willow flycatcher, great-crested flycatcher, and hairy, downy, red-bellied, and red-headed woodpeckers were common summer residents of creek forests. The barred owl was observed in this habitat during all seasons.

Amphibians and Reptiles

Number of species which may occur: 38
Rare or endangered species which may occur: Eastern wood frog
Species commonly observed or typically associated: Spotted salamander, small-mouthed salamander, slimy salamander, Blanchard's cricket frog, upland chorus frog, northern spring peeper, eastern gray treefrog, bullfrog, green frog, southern leopard frog, ground skink, eastern box turtle

Vegetative diversity, as well as the presence of permanent and semipermanent water in the form of creeks and forest pools, contributed to the importance of this habitat for moist-woodland amphibians and reptiles. Decayed logs, abundant in most creek forests, provided excellent habitat for the slimy, spotted, and small-mouthed salamanders. Eastern box turtles were also abundant. Although usually temporary, the numerous water-filled depressions were utilized for breeding by the upland chorus frog, Blanchard's cricket frog, the eastern gray treefrog, and northern spring peeper. Bullfrogs, southern leopard frogs, green frogs, and the ground skink were observed along brushy creek borders where they fed on insects.

Macroinvertebrates

Total genera collected: 145 (757 individuals)
Classes collected: 2 (spiders and mites, insects)
Number of genera identified per order: 21 genera of spiders, 1 tick, 1 springtail, 1 stonefly, 2 grasshoppers, 26 beetles, 1 thrip, 8 true bugs, 13 leafhoppers, 1 lacewing, 49 flies, 15 bees and wasps, 6 butterflies

Floodplain Forest Habitat

Floodplain forests commonly bordered streams and tributaries. These forests were characterized by slight topographic relief, seasonal inundation, and poorly drained soils.

Vegetation

Seasonal flooding, prolonged standing water, and competition reduced development of the herbaceous layer; 116 species representing 47 families were recorded in this habitat. Fewer plant species were present in floodplain forest than in any other forest type.

The dominant trees in floodplain forest were red maple, sweetgum (*Liquidambar styraciflua*), pin oak, ashes, and river birch. Other important associated tree species were American elm, black cherry, and silver maple (*Acer saccharinum*). Red maple, American elm, and slippery elm were the most important species in the shrub layer. In the understory, poison ivy, spotted touch-me-not, honey suckle (*Lonicera japonica*), spice-bush (*Lindera benzoin*), and trumpet creeper (*Campsis radicans*) were the most important cover species.

Red maple was the dominant species in both the tree and the shrub layers. This water- and shade-tolerant species was well suited to conditions of the floodplain forest.

Mammals

Number of species which may occur: 24

Rare or endangered species which may occur: Gray bat, Indiana bat, bobcat

Species commonly observed or typically associated: Opossum, short-tailed shrew, raccoon, eastern gray squirrel, white-footed mouse

Although lacking a diverse herbaceous layer, tree and shrub layer diversity attracted the typical bottomland forest species such as opossum, raccoon, and eastern gray squirrel. Seasonal inundation, poor drainage, and lack of herbaceous vegetation apparently limited the occurrence of woodchuck dens in this habitat.

Small mammal trapping success, averaging 3.8 captures/100 TN for all seasons, yielded four species; the white-footed mouse and deer mouse comprised approximately 84 and 9 percent, respectively, of the captures (Table 15). Trapping success was apparently influenced by spring flooding, as trapping success decreased from a high of 5.9 captures/100 TN prior to spring flooding to 2.7 captures/100 TN following flooding.

Birds

Number of species which may occur: 93

Rare or endangered species which may occur: Black-crowned night heron, black duck, hooded merganser, sharp-shinned hawk, red-shouldered hawk, marsh hawk, long-eared owl, yellow-bellied sapsucker, red-breasted nuthatch, brown creeper, veery, solitary vireo, Nashville warbler (Peregrine falcon and Swainson's warbler--unusual occurrence)

Species commonly observed or typically associated: Woodpeckers, American robin, starling, common grackle, kinglets, Carolina chickadee, cardinal

Floodplain forest had many dead trees that provided excellent habitat for woodpeckers throughout all seasons. Downy, red-bellied, and red-headed woodpeckers were abundant. The rare yellow-bellied sapsucker was sighted on dead timber during the winter. Of 23 winter species recorded, the American robin, starling, common grackle, golden-crowned and ruby-crowned kinglets, and Carolina chickadee were most common.

During spring, 31 species were recorded. Shrub and canopy vegetation provided resting cover for migratory wood warblers, thrushes, and the rose-breasted grosbeak. Two rare brown creepers and the rare sharp-shinned hawk

were sighted in this habitat during spring. A wood duck and a rare black duck were observed; wood ducks may use areas with sufficient permanent water as nest sites.

Summer breeding birds commonly seen were the cardinal, Carolina chickadee, and several woodpeckers. Less abundant, but recorded for the area, were the gray catbird, yellow-billed cuckoo, and blue-gray gnatcatcher, all summer residents of southern Illinois that typically nest in floodplain forests.

Amphibians and Reptiles

Number of species which may occur: 35
Rare or endangered species which may occur: Eastern wood frog
Species commonly observed or typically associated: Small-mouthed salamander, slimy salamander, Blanchard's cricket frog, upland chorus frog, northern spring peeper, eastern gray treefrog, eastern box turtle, black rat snake

Except for poorer drainage and prolonged periods of standing water, floodplain forests were topographically similar to many creek forests and, consequently, supported similar amphibian and reptile populations. The abundance of standing water contributed significantly to the importance of this habitat as a breeding area for most amphibians. The most abundant reptile was the eastern box turtle, frequently observed during the spring mating season.

Macroinvertebrates

Total genera collected: 116 (631 individuals)
Classes collected: 2 (spiders and mites, insects)
Number of genera identified per order: 24 genera of spiders, 1 springtail, 1 dragonfly, 1 grasshopper, 19 beetles, 1 thrip, 2 true bugs, 11 leafhoppers, 44 flies, 10 bees and wasps, 2 butterflies

Lowland Old Field Habitat

Old fields represented previously abandoned cropland. The vegetation was usually shrubby in appearance and less than 10 feet in height. Lowland old field occurred most commonly near streams, sloughs, or drainageways and exhibited early to late secondary successional stages associated with idled cropland. Seasonal inundation, poor soil drainage, and lower slope position were characteristics of lowland old fields.

Vegetation

This habitat exhibited the greatest species diversity of all habitats with 167 species representing 51 families recorded. The transitional nature of lowland old fields, representing early stages of succession, was reflected by this variety of plant species, particularly the abundance of weedy herbs and graminids.

All layers of vegetation (tree, shrub, and herbaceous) were present. Lowland old fields in early successional stages had a well-developed understory layer, with tree and shrub layer development occurring in later stages. As flooding and prolonged standing water were characteristic, many plants were adapted to seasonal wet-site conditions. The dominant tree species in later stages of lowland old field included cottonwood (*Populus deltoides*), black willow (*Salix nigra*), sycamore, red oak (*Quercus rubra*), and river birch. Other important associated trees were persimmon (*Diospyros virginiana*), sassafras, and the false shagbark-pignut hickory (*Carya ovalis*-*C. glabra*) group.

The most important species in the shrub layer were black willow, sycamore, and black oak. In the understory, fescue (*Festuca elatior*), broom sedge (*Andropogon virginicus*), goldenrod (*Solidago* sp.), trumpet

creeper, and rice cut grass (Leersia oryzoides) were the dominant cover species.

Mammals

Number of species which may occur: 24
Rare or endangered species which may occur: Southeastern shrew, rice rat
Species commonly observed or typically associated: Least shrew, red fox, deer mouse, bog lemming, prairie vole, house mouse, meadow jumping mouse, eastern cottontail, white-tailed deer

The well-developed herbaceous layer of this habitat contributed to the abundance and diversity of small mammals. Poor drainage apparently limited the utilization of this habitat by woodchucks, as only 26 percent of the transects contained active dens with an average of 0.4 dens per transect.

Small mammal trapping success averaged 5.1 captures/100 TN and yielded nine species (Tables 13 and 15). The deer mouse, prairie vole, and least shrew accounted for more than 55 percent of all captures (Table 15). Indicative of the moist conditions was the local abundance of bog lemmings; more than 71 percent of the lemmings captured were taken in lowland old fields.

Birds

Number of species which may occur: 78
Rare or endangered species which may occur: American bittern, common snipe, short-eared owl, loggerhead shrike, Bewick's wren, Bachman's sparrow (Swainson's warbler, black rail, and LeConte's sparrow--unusual occurrence)
Species commonly observed or typically associated: Common grackle, starling, dark-eyed junco, sparrows, red-winged blackbird, indigo bunting

Twenty-eight, 30, and 28 bird species were sighted during winter, spring, and summer, respectively, in lowland old field habitat. The greatest number of individuals, 394, occurred in winter. Blackbirds,

grackles, starlings, juncos, and sparrows comprised almost 90 percent of all observed winter birds. Flooded depressions provided water for birds, and dried weed seeds were an available food source. While cover was sufficient in lowland old fields for sparrows, blackbirds and grackles frequented adjacent woodland for winter roosts.

Standing water and moist ground in the spring and summer continued to make this habitat attractive to many winter residents. The red-winged blackbird, common grackle, and swamp sparrow were the most common spring species. The indigo bunting, a summer resident of southern Illinois, was the most abundant breeding bird in the summer census; common grackles, red-winged blackbirds, and brown-headed cowbirds were also common. Brushy, moist edges of lowland old fields provided nesting sites for the frequently seen yellow-breasted chat and Kentucky warbler.

Amphibians and Reptiles

Number of species which may occur: 21
Rare or endangered species which may occur: None
Species commonly observed or typically associated: Fowler's toad, eastern box turtle, hognose snake, rough green snake, eastern yellow-bellied racer, black rat snake, prairie kingsnake, eastern garter snake, northern copperhead

The diverse herbaceous layer and occasional standing water of lowland old fields provided suitable habitat for many reptiles. Most numerous were the eastern yellow-bellied racer, black rat snake, and prairie kingsnake, which fed upon insects and small mammals. Although more commonly found in drier upland forests, the poisonous northern copperhead was recorded from this habitat. Subadult eastern box turtles were numerous in lowland old fields and occasionally scavenged upon small mammals caught in traps.

Macroinvertebrates

Total genera collected: 144 (736 individuals)
Classes collected: 2 (spiders and mites, insects)
Number of genera identified per order: 20 genera of spiders, 1 mite, 1 springtail, 4 grasshoppers, 42 beetles, 1 thrip, 1 book lice, 8 true bugs, 15 leafhoppers, 1 lacewing, 34 flies, 13 bees and wasps, 3 butterflies

Pond and Pond Bank Habitat

Pond and pond bank habitat included small, permanent water areas such as ponds, marshes, sloughs, and the associated buffer areas located between the aquatic and the terrestrial habitats.

Vegetation

Pond and pond bank habitat was dominated by aquatic and wet-site plant species; 89 species representing 40 families were recorded. In permanent water areas, common aquatic plants were yellow pond lily (*Nuphar advena*), water starwort (*Callitrichi heterophylla*), slender naiad (*Naias flexibilis*), and false loosestrife (*Ludwigia palustris*).

As buffer areas were subject to seasonal inundation, water-tolerant plants predominated. The dominant trees included river birch, black willow, sycamore, red maple, and American elm. Associated trees were boxelder (*Acer negundo*), ashes, and musclewood (*Carpinus caroliniana*).

American elm, red maple, and river birch were the most important shrub layer species. In the understory, rice cut grass, false loosestrife, smartweeds (*Polygonus* spp.), tickseeds (*Bidens* spp.), and buttonbush (*Cephalanthus occidentalis*) were the most important plants.

Mammals

Number of species which may occur: 13
Rare or endangered species which may occur: Rice rat
Species commonly observed or typically associated: Opossum, big brown bat, raccoon, mink, beaver, bog lemming, muskrat

Pond and pond banks provided food and cover for those mammals typically associated with floodplain and creek forests, as well as the aquatic furbearers such as beaver and muskrat. Most ponds provided poor beaver and muskrat habitat as they were generally less than 1/2 acre and lacked emergent vegetation. Beaver sign was observed only once during the spring in a small pond. Only 3 of the 33 ponds surveyed contained active muskrat dens (average 1.5 dens per acre); all active woodchuck dens were located along the earthen dams.

Small mammal trapping success averaged 2.9 captures/100 TN and yielded six species. The low capture success for small terrestrial rodents was due to the high percentage of aquatic habitat in the transects. Percent species composition of small mammals trapped in this habitat reflected the mixture of moist old field and woodland vegetation; the white-footed mouse, a forest species, and the deer mouse, a species of brushy areas, accounted for approximately 32 and 45 percent, respectively, of the captures (Table 15).

Birds

Number of species which may occur: 99

Rare or endangered species which may occur: American bittern, black duck, pintail, northern shoveler, canvasback, ruddy duck, hooded merganser, red-shouldered hawk, marsh hawk, yellow rail, common snipe, Nashville warbler (Double-crested cormorant and little blue heron--unusual occurrence)

Species commonly observed or typically associated: Waterfowl, marsh hawk, woodpeckers, common flicker, common grackle, green heron, swamp sparrow, indigo bunting, Carolina wren, red-winged blackbird

Four, 24, and 20 species were observed during the winter, spring, and summer censuses, respectively. In winter, these water areas were primarily utilized by wintering and migratory waterfowl. The ring-necked duck, lesser scaup, mallard, and blue-winged teal were observed resting and feeding on

the ponds. The rare marsh hawk, which feeds on fish and rodents, was also observed.

Small dead trees in and around ponds were attractive to red-bellied, downy, and red-headed woodpeckers and common flickers. Weedy vegetation and shrubby buttonbush along the pond edges supplied nesting sites for the red-winged blackbird, an abundant species in this habitat. Brushy, moist cover was also attractive to the rare Nashville warbler and veery, both observed during spring migration.

The most commonly observed bird during the breeding season was the common grackle, comprising over 20 percent of all birds observed. Other commonly observed species were the green heron, swamp sparrow, indigo bunting, and Carolina wren. The moist, muddy shorelines provided foraging areas for the less abundant solitary sandpiper and American woodcock.

Amphibians and Reptiles

Number of species which may occur: 36
Rare or endangered species which may occur: Mud turtle
Species commonly observed or typically associated: Fowler's toad, Blanchard's cricket frog, upland chorus frog, northern spring peeper, bullfrog, southern leopard frog, common snapping turtle, midland painted turtle, red-eared turtle, rough green snake, northern copperbelly, midland water snake

The aquatic and terrestrial environments of ponds and pond banks provided essential habitat for a wide variety of amphibians and reptiles. Upland chorus frogs, the northern spring peeper, and southern leopard frogs began breeding in the ponds as early as March, while Blanchard's cricket frog and bullfrogs generally began in April. The common snapping turtle, midland painted turtle, and red-eared turtle were commonly observed in the larger ponds of the study area. The rough green snake foraged among overhanging bank vegetation for insects, while the northern copperbelly and midland water snake foraged in the water for amphibians and fish.

Macroinvertebrates

Total genera collected: 171 (1,590 individuals)
Classes collected: 2 (spiders and mites, insects)
Number of genera identified per order: 31 genera of spiders, 1 mite, 1 springtail, 2 dragonflies, 2 grasshoppers, 36 beetles, 1 thrip, 11 true bugs, 16 leafhoppers, 47 flies, 20 bees and wasps, 3 butterflies

Upland Forest Habitat

Upland forests were located on mid to upper slopes where soil drainage was rapid. These forests occurred in conjunction with tributary valleys, along topographic gradients from mid to upper slope, and in other well-drained soils.

Vegetation

Upland forest vegetation exhibited well-developed tree and shrub layers; however, shading, lower moisture levels, and competition from tree seedlings reduced understory development. As moderate to high topographic relief and rapid soil drainage were common, many plants were adapted to moderately xeric (dry) conditions. A total of 144 species representing 52 families were recorded.

An oak-hickory association dominated the tree and shrub layers. Dominant trees included the _Carya ovalis-C. glabra_ group, shagbark hickory (_C. ovata_), post oak (_Quercus stellata_), white oak (_Q. alba_), and black oak (_Q. velutina_). Associated tree species were shingle oak (_Q. imbricaria_), ash, and red oak.

Important shrub layer species were the _Carya ovalis-C. glabra_ group, shingle oak, sassafras, and shagbark hickory. In the understory, poison ivy, Virginia creeper, summer grape (_Vitis aestivalis_), sassafras, and ashes were the most important species.

Mammals

Number of species which may occur: 27
Rare or endangered species which may occur: Gray bat, Indiana bat, bobcat
Species commonly observed or typically associated: Short-tailed shrew, gray fox, eastern chipmunk, eastern gray squirrel, eastern fox squirrel, white-footed mouse, southern flying squirrel, pine vole

Large stands of mature upland oak-hickory forests, as well as smaller farm woodlots, provided excellent habitat for squirrels. In addition to populations of southern flying squirrels and eastern chipmunks, the mature upland forests supported eastern gray squirrels, averaging 1.6 squirrels per acre. The less mature, open woodlots were dominated by eastern fox squirrels.

Small mammal trapping yielded six species (average 3.2 captures/100 TN), with two typical forest species, the white-footed mouse and short-tailed shrew, representing more than 80 percent of all captures (Tables 13 and 15). The pine vole, another small mammal characteristic of forests, accounted for more than 31 percent of the total captures for this species in all habitat types (Table 15).

Birds

Number of species which may occur: 78
Rare or endangered species which may occur: Sharp-shinned hawk, Cooper's hawk, long-eared owl, yellow-bellied sapsucker, Bewick's wren, veery, solitary vireo, Nashville warbler (Pine warbler--unusual occurrence)
Species commonly observed or typically associated: Common grackle, blue jay, tufted titmouse, Carolina chickadee, white-breasted nuthatch, woodpeckers, cardinal, whip-poor-will

Upland forests provided food and shelter for a wide variety of birds throughout the year. During the winter, 473 individuals in 14 species were observed. Roosting flocks of the common grackle accounted for over 85 percent of all birds observed. The blue jay, tufted titmouse, Carolina

chickadee, and white-breasted nuthatch were common winter residents; the rare brown creeper was also observed. Dead trees were utilized by several species of woodpeckers.

Thirty-one species, totaling 183 individuals, were observed during spring censuses in upland forests. This habitat was especially attractive to spring and fall migratory wood warblers. The cardinal, tufted titmouse, blue jay, and yellow-rumped warbler were commonly sighted. Dead trees provided insects and nest holes for the rare yellow-bellied sapsucker, while brushy forest edge sheltered the rare Bewick's wren.

Two-thirds of the 32 species observed in the summer were Passeriformes (perching birds). Upland forest provided food and cover for the eastern pewee, orioles, tanagers, and vireos. The most common species in summer were the cardinal and the blue jay. Diurnal roosts of the nocturnal, insectivorous chuck-will's-widow and whip-poor-will were frequently encountered in this forest.

Amphibians and Reptiles

Number of species which may occur: 22

Rare or endangered species which may occur: Western slender glass lizard, timber rattlesnake

Species commonly observed or typically associated: Slimy salamander, Fowler's toad, northern fence lizard, six-lined racerunner, eastern hognose snake, black rat snake, northern copperhead

Dry-site conditions of this habitat favored several species of snakes, but few amphibians. Although characteristic of moist creek or floodplain forests, slimy salamanders were occasionally encountered under debris on upland forest slopes. One eastern hognose snake and several black rat snakes were also observed on dry, forested slopes, while six-lined racerunners, northern fence lizards, Fowler's toads, and northern copperheads occupied the drier upper slopes and ridges.

Macroinvertebrates

Total genera collected: 113 (790 individuals)
Classes collected: 2 (spiders, insects)
Number of genera identified per order: 19 genera of spiders, 1 springtail, 1 grasshopper, 20 beetles, 2 true bugs, 6 leafhoppers, 1 caddisfly, 3 butterflies, 43 flies, 17 bees and wasps

Upland Old Field Habitat

Upland old fields occurred most commonly on well-drained soils on mid to upper slopes. This habitat represented early to middle secondary successional stages associated with abandoned cropland.

Vegetation

This habitat exhibited the second greatest species diversity with 159 species of 54 families. As with lowland old fields, species diversity in upland old fields was mostly represented by weedy and graminid plants.

Tree, shrub, and herbaceous layers were usually present in this habitat type. A well-developed understory layer was evident in early upland old field with tree and shrub development in later stages. Plants adapted to moderately xeric conditions were prevalent in this habitat.

Differences in tree and shrub layer compositions between upland and lowland old field were more pronounced, suggesting ultimate, successional advancement toward different forest types. Dominant trees in later stages of upland old field development were sassafras, pin oak, black oak, ashes, and flowering dogwood (*Cornus florida*). Important associated trees were persimmon, black cherry, and red maple.

Important shrub layer species were sassafras, black oak, and shagbark hickory. Broom sedge, dwarf sumac (*Rhus copallina*), fescue, morning-glory (*Ipomoea* sp.), and curly grass (*Danthonia spicata*) were most abundant in the understory.

Mammals

Number of species which may occur: 22
Rare or endangered species which may occur: Southeastern shrew
Species commonly observed or typically associated: Eastern mole,
least shrew, long-tailed weasel, red fox, deer mouse, prairie
vole, house mouse, eastern cottontail, white-tailed deer

The vegetative similarity of lowland and upland old field habitats was reflected in similar mammalian compositions. Noteable exceptions included a decrease in bog lemmings, attributable to the xeric conditions of upland old fields. The long-tailed weasel and red fox, both important predators of small rodents, were observed. The successional vegetation provided excellent food and cover for both eastern cottontails and white-tailed deer.

Small mammal trapping success averaged 4.6 captures/100 TN and yielded eight species, an indication of the vegetational diversity of upland old fields. The least shrew, deer mouse, and prairie vole accounted for almost 75 percent of all captures; the white-footed mouse accounted for only 12 percent of all captures (Table 15).

Birds

Number of species which may occur: 64
Rare or endangered species which may occur: Marsh hawk, upland
sandpiper, short-eared owl, brown creeper, Bewick's wren,
Nashville warbler, Brewer's blackbird, Bachman's sparrow
(LeConte's sparrow--unusual occurrence)
Species commonly observed or typically associated: Common grackle,
dark-eyed juncos, bobwhite quail, field sparrow, American
goldfinch, Carolina chickadee, cardinal

Upland old field provided both shelter and food for birds throughout the year. The number of species recorded per season was 20, 18, and 27, respectively. The number of individuals was greatest in winter with 342 birds, decreasing to 64 birds in spring, and increasing to 88 during summer.

Common grackle flocks composed over 70 percent of all birds observed in all upland old fields during winter. Smaller flocks of dark-eyed juncos were also common. Wintering bobwhite coveys of four to five birds were frequently seen. Dried seeds of herbaceous plants provided a food source during this season.

The field sparrow was the most common bird during spring and nested in low grassy and shrubby vegetation. The brown-headed cowbird, field sparrow, American goldfinch, Carolina chickadee, and cardinal were most abundant during the summer period. Eastern bluebirds and indigo buntings also frequented upland old fields.

The majority of birds utilizing upland old fields were edge species, which typically utilize several adjoining habitats. No rare or endangered species were observed in this habitat.

Amphibians and Reptiles

Number of species which may occur: 15
Rare or endangered species which may occur: Western slender glass lizard, timber rattlesnake
Species commonly observed or typically associated: Fowler's toad, six-lined racerunner, eastern yellow-bellied racer, black rat snake, prairie kingsnake, eastern garter snake

Commonly observed species of upland old field were similar to those found in upland forest. Additional species included the eastern yellow-bellied racer, prairie kingsnake, and eastern garter snake. Although occasionally observed along roadside ditches, the prairie kingsnake was more abundant in upland old fields, particularly in the denser herbaceous vegetation.

Macroinvertebrates

Total genera collected: 137 (960 individuals)
Classes collected: 2 (spiders and mites, insects)
Number of genera identified per order: 21 genera of spiders, 1 tick, 1 grasshopper, 42 beetles, 1 thrip, 1 book lice, 12 true bugs, 16 leafhoppers, 22 flies, 15 bees and wasps, 5 butterflies

Hedgerow Habitat

Hedgerow habitat was any strip of woody vegetation 100 feet or less in width. Hedgerows occurred adjacent to streams, tributaries, and drainage ditches, bordering cultivated fields, and in conjunction with fencerows and roadsides.

Vegetation

As hedgerows were in a variety of locations representing variable site conditions, hedgerows often exhibited combinations of plant species typical to other habitat types. Diversity was less in planted hedgerows than in non-planted ones. A total of 116 plant species in 49 families was recorded in this habitat.

Hedgerow habitat exhibited well-developed tree, shrub, and herbaceous layers. The dominant tree species included osage-orange (*Maclura pomifera*), sassafras, black cherry, American elm, and pin oak. Associated trees were honey locust (*Gleditsia triacanthos*), red maple, and sugarberry (*Celtis laevigata*).

The shrub layer contained sassafras, American elm, and black cherry. In the understory, Japanese honeysuckle, poison ivy, buckbrush, Canada blue grass (*Poa compressa*), and trumpet creeper were the most abundant cover species.

Mammals

Number of species which may occur: 21
Rare or endangered species which may occur: Southeastern shrew
Species commonly observed or typically associated: Least shrew, raccoon, long-tailed weasel, striped skunk, house mouse, eastern cottontail, white-tailed deer

The blend of forest, old field, and cultivated field habitats as represented by hedgerows was reflected by the variety of associated mammalian species. Hedgerows and adjacent cropland provided excellent food and cover for several game and furbearer species including eastern cottontails, white-tailed deer, raccoons, and striped skunks.

Small mammal trapping success was greatest in this habitat, with an average of 5.8 captures/100 TN (Table 13). Diversity was also high with nine species represented in the trapping results. Of all house mice captured, more than half were taken in hedgerows; the house mouse is a characteristic species of hedgerows and other brushy habitats. One uncommon species, the meadow jumping mouse, was also recorded.

Birds

Number of species which may occur: 74
Rare or endangered species which may occur: Cooper's hawk, marsh hawk, brown creeper, Bewick's wren, loggerhead shrike
Species commonly observed or typically associated: Dark-eyed junco, cardinal, meadowlark, sparrows, American robin, mourning dove, brown thrasher, mockingbird, common grackle, red-winged blackbird, bobwhite quail

Hedgerows provided protection from strong winter and spring winds, and the adjacent cultivated and fallow fields yielded grain and insects. Although the number of species seen (29, 28, and 37 per season) was fairly consistent, the number of individuals varied greatly--405 in the winter, 183 in spring, and 247 in summer.

Flocking activity of the dark-eyed junco, cardinal, blue jay, purple finch, meadowlark, and tree, field, and white-crowned sparrows contributed

to the high number of individuals observed during the winter. These eight species comprised nearly 85 percent of all birds observed in hedgerows during winter. The rare marsh hawk was also observed during the winter census.

In spring, large flocks were less common, and individuals were more prevalent. In addition to small flocks and individuals of the above-mentioned species, the American robin, red-winged blackbird, eastern kingbird, mourning dove, brown thrasher, and mockingbird were regularly observed. Less frequently seen, but still common, were the rufous-sided towhee and common yellowthroat. The rare brown creeper was sighted ascending trunks of larger shrubs and trees in hedgerow habitat.

The common grackle, red-winged blackbird, cardinal, and bobwhite quail were the most commonly observed birds during the breeding season. The chimney swift, brown-headed cowbird, and barn swallow were frequently seen flying over hedgerows in summer. The latter two species often utilized hedgerows for resting and shelter. During the summer, four rare loggerhead shrikes were observed sitting on wires; they escaped to hedgerow cover when flushed.

Amphibians and Reptiles

Number of species which may occur: 9
Rare or endangered species which may occur: None
Species commonly observed or typically associated: Northern fence lizard, eastern yellow-bellied racer, black rat snake, prairie kingsnake, eastern garter snake

The brushy and woody vegetation of hedgerows provided similar habitat conditions as found in late successional stages of upland and lowland old fields and, consequently, supported similar species of amphibians and reptiles. The most characteristic hedgerow species were the northern

fence lizard, frequently observed sunning on fence posts and tree trunks, and the eastern garter snake, observed along the brushy edges of hedgerows adjacent to roadsides. One uncommon species, the dwarf American toad, was observed along a densely vegetated hedgerow of a lowland area.

Macroinvertebrates

Total genera collected: 155 (969 individuals)
Classes collected: 2 (spiders and mites, insects)
Number of genera identified per order: 31 genera of spiders, 1 tick, 1 springtail, 3 grasshoppers, 27 beetles, 1 thrip, 1 book lice, 12 true bugs, 17 leafhoppers, 39 flies, 20 bees and wasps, 2 butterflies

Anthropogenic Land Habitat

Anthropogenic lands were areas altered or continually affected by man. These habitats existed most commonly as cropland, refuse sites, building sites, roads, railroads, and road and railroad rights-of-way.

Vegetation

Vegetation was usually absent from road and railroad beds and refuse sites. Cropland, building sites, and rights-of-way exhibited some form of vegetation during the year. Major cultivated crops in this area were corn, soybeans, and wheat. Mono-agricultural practices greatly reduced the variety of plant species associated with cropland. Several weed species, shepherd's purse (*Capsella bursa-pastoris*), wild onion (*Allium canadense*), common peppercress (*Lepidium virginicum*), and mouse-ear cress (*Arabidopsis thaliani*), usually occurred in cultivated fields.

Vegetative composition of building sites and rights-of-way was dependent upon frequency and nature of site conditions and man's activities. These areas usually had a variety of weedy herbs, graminids, and woody plant species with vegetational compositions similar to successional, old

field habitats. A total of 96 species representing 34 families was recorded in this habitat type.

Mammals

Number of species which may occur: 17
Rare or endangered species which may occur: None
Species commonly observed or typically associated: Eastern mole, little brown bat, big brown bat, domestic dog, house cat, house mouse, eastern cottontail, white-tailed deer

Abandoned buildings provide daytime roosting habitat for the common big brown and little brown bats. Norway rats and house mice utilized the debris of abandoned buildings. Domestic cats, as well as free-ranging dogs, play significant roles as predators in this habitat. Small packs of free-ranging dogs were frequently observed foraging at refuse sites and were once observed running a white-tailed doe and fawn. Although not restricted to this habitat, the eastern mole and eastern cottontail were commonly associated with habitats surrounding farmsteads.

Birds

Number of species which may occur: 69
Rare or endangered species which may occur: Yellow rail, upland sandpiper, loggerhead shrike, Brewer's blackbird
Species commonly observed or typically associated: Common grackle, rusty blackbird, horned lark, dark-eyed junco, mourning dove, house sparrow, starling, American robin, mockingbird, chimney swift, nighthawk, swallows, killdeer, meadowlark, turkey vulture, red-tailed hawk

Stubble grain, corn, and plowed fields attracted large flocks of common grackles, rusty blackbirds, brown-headed cowbirds, horned larks, and dark-eyed juncos during the winter. Flocks of over 250 mourning doves foraged in fields and rested on nearby wires. Gravel roads were used as dusting and grit sources by this species. The Canada goose, seen flying over the area in winter, may feed in standing or cut corn fields.

Homesteads and lawns were attractive to the house sparrow, starling, American robin, and mockingbird throughout the year. Rock doves were observed around barns. Buildings and gardens provided nesting spots for summer residents such as the chimney swift, nighthawk, orioles, and several swallows. Indigo buntings were common near residential areas, while the ruby-throated hummingbird frequented residential gardens.

Brushy cover surrounding agricultural land was utilized for nesting by the killdeer and eastern meadowlark. Bobwhites frequented agricultural land and adjacent hedgerows. The endangered upland sandpiper was observed feeding in plowed fields during spring. The most common raptor of the study area was the red-tailed hawk; the turkey vulture was often seen soaring over agricultural land during spring and summer.

Amphibians and Reptiles

Number of species which may occur: 7
Rare or endangered species which may occur: None
Species commonly observed or typically associated: Fowler's toad, eastern box turtle, northern fence lizard, six-lined racerunner, five-lined skink, black rat snake

Overall species composition of anthropogenic land was similar to that of old field habitat. Abandoned railroad grades provided a rocky, xeric habitat utilized by northern fence lizards and six-lined racerunners. One species, the five-lined skink, was recorded only from this habitat.

Macroinvertebrates

No invertebrate collections were made in this habitat type.

B. Rare and Endangered Species of the Delta Expansion Area

Only plants actually encountered on the Delta expansion area were placed in this section; their rare or endangered status was based on

Gleason and Cronquist (1963), Jones (1963), and Britton and Brown (1913) or on information from competent authorities as cited in the text. Those animal species whose ranges include the study area and whose status has been determined to be rare or endangered in the State of Illinois (Illinois Nature Preserves Commission 1971) were discussed. The following definitions were taken from Illinois Nature Preserves Commission (1971).

A species or subspecies was considered rare if it had a very restricted range and/or population level in Illinois. In some cases, the animal may be at the border of its natural range and so may be abundant outside Illinois. Birds which are common as migrants may be rare as breeding populations. The term "rare" indicates that the species is not presently in danger of extirpation from Illinois.

A species or subspecies was considered endangered if it was in danger of extirpation from Illinois due to habitat destruction or to low population levels. The term applies both to breeding populations and to species that regularly migrate through or winter in Illinois.

Plants[1]

Adder's-Tongue *Ophioglossum vulgatum* L. Rare

Preferred Habitat: Open woods, meadows, swamps, and moist thickets.
Habitat Where Found on Study Area: Moist creek forest ravine.
Illinois Distribution: Southern Illinois.
Number Observed: 1 individual.

Pine Sap *Monotropa lanuginosa* Michx. Rare

Preferred Habitat: Moist and dry woods.
Habitat Where Found on Study Area: Dry rocky upland forest.
Illinois Distribution: Disjunct populations throughout the State.
Number Observed: 12 individuals in 1 location.

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[1] Information concerning nomenclature, range, and ecological requirements was taken from Jones (1963), Gleason and Cronquist (1963), and Britton and Brown (1913).

Blunt-leaved Milkweed *Asclepias amplexicaulis* Sm. Rare (according to R. H. Mohlenbrock, Botany Dept., Southern Illinois University-Carbondale)

Preferred Habitat: Dry fields, prairies and open woods, usually in sandy soil.
Habitat Where Found on Study Area: Open upland forest.
Illinois Distribution: Northern and central part of State.
Number Observed: 1 individual.

Mammals[2]

Southeastern Shrew *Sorex longirostris longirostris* Bachman Rare

Preferred Habitat: Bogs, marshes, and swamps, as well as moist open fields and woodlots.
Illinois Distribution: Union, Alexander, Pope, Coles, Fayette, and Johnson counties.
Number Observed: 0

Gray Bat *Myotis grisescens* (Howell) Rare

Preferred Habitat: Limestone caverns.
Illinois Distribution: Southern half of State.
Number Observed: 0

Indiana Bat *Myotis sodalis* Miller and Allen Endangered

Preferred Habitat: Caves.
Illinois Distribution: State-wide.
Number Observed: 0

Bobcat *Lynx rufus rufus* (Schreber) Endangered

Preferred Habitat: Extensive wooded bottomlands, bluffs, and river borders.
Illinois Distribution: Southern and northwestern Illinois.
Number Observed: 0

Rice Rat *Oryzomys palustris palustris* (Harlan) Rare

Preferred Habitat: Marshes and wet meadows.
Illinois Distribution: Southern one-fifth; Jackson, Union, Williamson, Johnson, Franklin, Alexander and Massac counties.
Number Observed: 0

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[2] All information concerning nomenclature, distribution, range, and ecological requirements was taken from Hoffmeister and Mohr (1957).

Birds[3]

Black-crowned Night Heron *Nycticorax nycticorax hoactli* (Gmelin) Rare

Preferred Habitat: Shores of rivers, small streams, and ponds.
Illinois Distribution: State-wide summer resident.
Number Observed: 0

American Bittern *Botaurus lentiginosus* (Rackett) Rare

Preferred Habitat: Reedy, swampy areas near water.
Illinois Distribution: State-wide summer resident.
Number Observed: 0

Black Duck *Anas rubripes* Brewster Rare

Preferred Habitat: Shores of small fresh-water lakes and ponds, usually near wooded areas.
Habitat Where Found on Study Area: Flying over floodplain forest.
Illinois Distribution: Winter resident in southern two-thirds of the State; summer resident in northern Illinois (Calumet marshes).
Number Observed: 2 (in April).

Pintail *Anas acuta* Linnaeus Rare

Preferred Habitat: Shallow ponds and swampy stream borders.
Habitat Where Found on Study Area: Flying over lowland old field.
Illinois Distribution: Rare summer resident in southern Illinois; migratory.
Number Observed: 7 (in January).

Northern Shoveler *Anas clypeata* (Linnaeus) Rare

Preferred Habitat: Small muddy pools, ponds, and mudholes.
Illinois Distribution: State-wide, migratory.
Number Observed: 0

Canvasback *Aythya valisineria* (Wilson) Rare

Preferred Habitat: Large bodies of water, ponds, lakes, large rivers, bays, and harbors.
Illinois Distribution: Rare winter resident on Mississippi River; migratory.
Number Observed: 0

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[3] All information concerning nomenclature, distribution, range, and ecological requirements was taken from Hausman (1946), American Ornithologists' Union (1957 and 1973), Graber and Golden (1960), Robbins et al. (1966), and Terpening et al. (1975). All rare or endangered birds seen and all species for which nesting, wintering, or migratory habitat was available on the study area were placed in this annotated list. Those considered accidental to this area were not included.

Ruddy Duck Oxyura jamaicensis rubida (Wilson) Rare

Preferred Habitat: Fresh and salt water ponds, creeks, and borders of rivers and lakes.
Illinois Distribution: Migratory.
Number Observed: 0

Hooded Merganser Lophodytes cucullatus (Linnaeus) Rare

Preferred Habitat: Woodland streams and ponds with tree cavities for nesting.
Illinois Distribution: State-wide; rare summer resident.
Number Observed: 0

Sharp-shinned Hawk Accipiter striatus velox (Wilson) Rare

Preferred Habitat: Open farming land with sparse deciduous or coniferous woodland.
Habitat Where Found on Study Area: Floodplain forest edge near lowland old field.
Illinois Distribution: State-wide permanent resident.
Number Observed: 1 (in May).

Cooper's Hawk Accipiter cooperii (Bonaparte) Endangered

Preferred Habitat: Open woodlands and wood margins.
Illinois Distribution: State-wide permanent resident.
Number Observed: 0

Red-shouldered Hawk Buteo lineatus lineatus (Gmelin) Endangered

Preferred Habitat: Lowland woods in farm country.
Habitat Where Found on Study Area: Lowland old field-floodplain forest edge.
Illinois Distribution: State-wide permanent resident.
Number Observed: 1 (in spring).

Bald Eagle Haliaeetus leucocephalus leucocephalus (Linnaeus) Endangered

Preferred Habitat: Forested areas near water.
Illinois Distribution: Mississippi River and southern Illinois; winter resident.
Number Observed: 0

Marsh Hawk Circus cyaneus hudsonius (Linnaeus) Rare

Preferred Habitat: Lowland fields, pastures, and brushy hillsides.
Habitat Where Found on Study Area: Pond edge; lowland old field; hedgerow; and upland old field.
Illinois Distribution: Permanent resident in north and central Illinois; winter resident in southern Illinois.
Number Observed: 5 (in January and February); 2 (in April and May).

Common Snipe *Capella gallinago gallinago* (Linnaeus) Rare

Preferred Habitat: Marshes and wet lowland fields with tall grasses.
Illinois Distribution: Summer resident in northern Illinois; winter resident state-wide.
Number Observed: 0

Upland Sandpiper *Bartramia longicauda* (Bechstein) Endangered

Preferred Habitat: Wet old fields and abandoned pastures; agricultural land.
Habitat Where Found on Study Area: Wet ploughed field.
Illinois Distribution: Summer resident in northern two-thirds of State; migratory through rest of State.
Number Observed: 2 (in April).

Common Tern *Sterna hirundo hirundo* Linnaeus Rare

Preferred Habitat: Islands and shores of large lakes.
Illinois Distribution: Migratory; summer resident in northeast Illinois.
Number Observed: 0

Barn Own *Tyto alba pratincola* (Bonaparte) Rare

Preferred Habitat: Abandoned barns and silos near plentiful rodent supplies.
Illinois Distribution: State-wide permanent resident.
Number Observed: 0

Long-eared Owl *Asio otus wilsonianus* (Lesson) Rare

Preferred Habitat: Dense woodland, preferably coniferous.
Illinois Distribution: Permanent resident in north-central Illinois; winter resident in south.
Number Observed: 0

Short-eared Owl *Asio flammeus flammeus* (Pontoppidan) Rare

Preferred Habitat: Open wetland fields.
Illinois Distribution: Winter resident in south; permanent resident in rest of State.
Number Observed: 0

Yellow-bellied Sapsucker *Sphyrapicus varius varius* (Linnaeus) Rare

Preferred Habitat: Wet pond and stream edges; forest; farming country with abundant trees.
Habitat Where Found on Study Area: Creek forest.
Illinois Distribution: Winter resident state-wide; summer resident in northern half of State.
Number Observed: 4 (in April).

Red-breasted Nuthatch *Sitta canadensis* Linnaeus Rare

Preferred Habitat: Forests, preferably coniferous.
Illinois Distribution: State-wide winter resident.
Number Observed: 0

Brown Creeper *Certhia familiaris americana* Bonaparte Rare

Preferred Habitat: Bottomland and upland woodlands.
Habitat Where Found on Study Area: Upland forest; floodplain forest; and hedgerow.
Illinois Distribution: State-wide permanent resident.
Number Observed: 1 (in February); 3 (in April).

Bewick's Wren *Thryomanes bewickii bewickii* (Audubon) Rare

Preferred Habitat: Brushy forest and farmyard edges.
Habitat Where Found on Study Area: Upland forest, abandoned road edge.
Illinois Distribution: State-wide permanent resident.
Number Observed: 2 (in March).

Veery *Catharus fuscescens fuscescens* (Stephens) Rare

Preferred Habitat: Moist, deciduous forest and wooded hillsides.
Habitat Where Observed on Study Area: Creek forest; upland forest.
Illinois Distribution: Migratory; summer resident in northeast Illinois.
Number Observed: 4 (in April and May).

Loggerhead Shrike *Lanius ludovicianus migrans* Palmer Rare

Preferred Habitat: Open farmland with wires and hedgerows.
Habitat Where Found on Study Area: Wires above hedgerows along roads.
Illinois Distribution: State-wide; permanent resident; rare summer resident in northern two-thirds of State.
Number Observed: 5 (in January and February); 1 (in April); 4 (in June).

Solitary Vireo *Vireo solitarius solitarius* (Wilson) Rare

Preferred Habitat: Moist to mesic forests with conifers.
Habitat Where Found on Study Area: Moist lower slope of upland forest.
Illinois Distribution: Migratory.
Number Observed: 1 (in April).

Nashville Warbler *Vermivora ruficapilla ruficapilla* (Wilson) Rare

Preferred Habitat: Trees and brush about wood and pond edges.
Habitat Where Found on Study Area: Pond edge.
Illinois Distribution: Migratory; summer resident in northeast Illinois.
Number Observed: 3 (in April).

Brewer's Blackbird *Euphagus cyanocephalus* (Wagler) Rare

Preferred Habitat: Farmyards, fields, and roadsides.
Illinois Distribution: Migratory; summer resident in northeast Illinois.
Number Observed: 0

LeConte's Sparrow *Ammospiza leconteii* (Audubon) Endangered--possibly extirpated

Preferred Habitat: Grassy fields and thickets.
Illinois Distribution: Migratory.
Number Observed: 0

Bachman's Sparrow *Aimophila aestivalis illinoensis* (Ridgway) Endangered

Preferred Habitat: Abandoned fields with dense ground cover.
Illinois Distribution: Local resident in central Illinois and southward.
Number Observed: 0

Amphibians and Reptiles[4]

Eastern Wood Frog *Rana sylvatica sylvatica* LeConte Rare

Preferred Habitat: Mesic forests with permanent or semipermanent pools.
Illinois Distribution: State-wide, but sporadic.
Number Observed: 0

Mud Turtle *Kinosternon subrubrum subrubrum* (Lacepede) x *hippocrepis* Gray Rare

Preferred Habitat: Ditches, ponds, and swamps.
Illinois Distribution: Southern one-third.
Number Observed: 0

Western Slender Glass Lizard *Ophisaurus attenuatus attenuatus* Cope Rare

Preferred Habitat: Timbered hillsides.
Illinois Distribution: State-wide.
Number Observed: 0

Timber Rattlesnake *Crotalus horridus horridus* Linnaeus Endangered

Preferred Habitat: Forested bluffs and rock outcrops.
Illinois Distribution: Southern half of State and Mississippi River counties.
Number Observed: 0

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[4] All information concerning nomenclature, distribution, range, and ecological requirements was taken from Smith (1961).

Of the 39 rare or endangered animals discussed in this section, only 13 species, all birds, were actually seen. Five of the rare birds, the sharp-shinned hawk, red-shouldered hawk, brown creeper, Bewick's wren, and loggerhead shrike, were considered permanent residents in southern Illinois and were sighted on the Delta expansion area in the spring, a possible indication that they were nesting on the site. The remaining eight rare or endangered birds were all winter residents or migratory visitors.

PART V: AQUATIC ENVIRONMENT

METHODS AND MATERIALS

Water Quality Sampling

Twenty-four sampling sites were selected. Originally all sites were randomly selected based on a numbering of all confluences of tributaries with the main channels of either Bankston Fork or Brushy Creek. However, because much of Bankston Fork flows through surface-mined land with limited access, sites were arbitrarily moved to more accessible points. An effort was made to retain tributaries originally selected randomly; where this was not possible, several sites were added at strategic points. Each point on Brushy Creek represented three sampling sites: on the tributary (T), above the confluence (AC), and below the confluence (BC). When actual sampling sites were fixed in the field, an effort was made to select characteristic stream segments. Thus, riffle areas were avoided on Brushy Creek, which is characteristically a slow-moving stream.

Sampling sites were visited monthly during February-September 1975 with the exception of June. Three trips were required to sample all sites in February; thereafter, collections were completed in two trips, generally within 1-3 days of each other. However, extensive rainfall after the first trip on 18 April delayed the second trip until 2 May (the latter is tabulated as part of the April collection). This was the only instance when rainfall between trips may have affected the comparability of the two collections. Samples were not taken during rainfall because of transient increases in turbidity and incomplete mixing of runoff with main stream flow.

At each site, air temperature was measured with a laboratory thermometer; water temperature and dissolved oxygen were measured with a YSI Model 51A meter. Relative observations regarding flow rate, water depth, and continuity were also made. If the traditional sampling site was dry, a search was made in both directions for 50-60 yards, and the nearest pool with sufficient water was sampled. If no pools were encountered, the site was classified as dry. Samples were collected in plastic bottles previously washed with 1:1 HCl and rinsed with demineralized distilled water. Samples were always drawn from the surface; if water depth was insufficient for immersion filling, small amounts were carefully dipped and transferred to the collection vessels. All bottles were filled to capacity and tightly sealed. Sufficient bottles were filled to allow analyses sensitive to gas exchange to be made from previously unopened containers.

Approximately 6 hours elapsed between initiation of sampling at sunrise and return to the Cooperative Wildlife Research Laboratory, SIU. Procedures for manganese, total iron, settleable matter, pH, and filtering were instituted immediately. Samples for dissolved orthophosphate were preserved by freezing (Golterman 1969:71). Samples for other analyses were preserved at 4°C and holding times recommended by Environmental Protection Agency (EPA) (1971:vii-xii) were followed, except sulfate and hardness samples were occasionally held for 10 days. All spectrophotometric analyses were made on a Turner 350 or Spectronic 20; standards were processed with each batch of samples and results calculated by linear regression after correction for reagent and sample blanks. Duplicate analyses were made for dissolved orthophosphate, nitrate nitrogen, and sulfate. Glassware for phosphate and total iron analyses was washed

with 1:1 HCl and rinsed with deionized distilled water. Class A volumetric glassware was used throughout.

At least 600 ml were filtered through washed Gelman type A-E glass fiber filters and preserved for the spectrophotometric determination of dissolved orthophosphate, nitrate nitrogen, and sulfate (Hach 1973; PhosVer III, NitraVer V, and SulfaVer IV reagents, respectively). NitraVer V depends on the reduction of nitrate to nitrite for color development and will therefore respond to nitrites originally present. However, nitrite concentrations are usually insignificant in natural waters under aerobic conditions (Brown et al. 1970:121). Sample pH was measured at 25°C with a Photovolt digital meter according to ASTM D-1293 (ASTM 1972:248-256). Soluble manganese and total iron were determined spectrophotometrically with the tetraphenyl arsonium chloride and FerroZine methods, respectively (Hach 1973). The 20-minute digestion used with the FerroZine reagent was capable of digesting metallic iron to a concentration of 2.8 mg/1; samples were always diluted to less than 1.6 mg/1 prior to digestion. Settleable matter was measured volumetrically (Standard Methods 1965:426). Turbidity was determined spectrophotometrically (Hach 1973) in Formazine Turbidity Units (FTU). The ManVer II titration method (Hach 1973) with the routine addition of sodium cyanide was used to measure total hardness. Alkalinity was measured by electrometric titration to pH 4.5 at 25°C (EPA 1974:3). Acidity was determined by electrometric titration at 25°C according to EPA (1971:5) except pH 8.2 was used as an endpoint. For most samples, low acidity required the use of a 10 ml buret and 0.01 N NaOH. Originally, acidity was also determined by electrometric titration of a boiled and oxidized sample (EPA 1974:1). Because this method was time consuming and yielded only net acidity, its use was discontinued except

when samples had a high iron concentration (ASTM 1972:150). For these samples, however, results of the two methods were not demonstrably different by a matched-pair t test ($t_{17} = 1.39$, $P > 0.10$, $r = +0.99$). Therefore, all acidity data are the results of the 1971 EPA method.

The precision and accuracy of the hardness titration and all spectrophotometric analyses except turbidity were estimated according to EPA (1972). Relative error was always less than 5 percent. In all cases, data have been rounded to a level of significance compatible with estimated precision. Data was punched on computer cards and analyzed with the aid of an IBM 370/155 computer.

Fish Sampling

Fish populations were sampled by dip net and seine at each stream hydrological sampling site (Fig. 6) in the spring and summer. In addition, four ponds were seined. All specimens captured were identified and preserved in 10 percent formalin.

Macroinvertebrate Sampling

Aquatic macroinvertebrates of streams were sampled with a Surbur sampler and a dip net at each hydrological sampling station. A 30-liter water sample was taken at each sampling site to analyze for aquatic microinvertebrates. Pond microorganisms were collected in 10-liter water samples. Organisms collected were preserved in 10 percent formalin for identification and counting.

RESULTS AND DISCUSSION

A. Water Quality of the Delta Expansion Area

Sampling site locations are shown in Figure 6 and detailed in Appendix H. Data from site #32 on Brushy Creek, site #38 on Bankston Fork, and site #300 on Bankston after the confluence with Brushy are of special interest because these stations provide information before and after flow through the Delta expansion area. Also, these sites will be undisturbed and available for future reference.

Data for each site were tabulated by month (Appendix I). Because of the large number of variables and sites monitored, it was necessary to group the data for analysis. Where appropriate, data for each variable were grouped according to site location on: (1) Brushy Creek, (2) Bankston Fork, or (3) a tributary of each main stream. It must be recognized that grouping data frequently causes a loss of information; this is particularly true for tributary classes because individual tributaries were frequently dissimilar. Data for tributaries of Brushy Creek are possibly representative, but during July-September only two of these carried water. Tributaries of Bankston Fork are known to be nonrepresentative because those entering from the south were not sampled; in addition, water quality at site #144 can be expected to reflect results from upstream sites #134 and #136 (Fig. 6). However, the Bankston Fork tributaries should be reasonably characteristic of present drainage from the south slope of the Delta expansion area.

General Stream Characteristics

Brushy Creek is characteristically a shallow, slow-moving stream with a high-water channel about 20 feet wide. Below site #125, channel width

increases to about 30 feet. The stream bottom is typically sand-gravel with local areas of silt deposition, especially at sites #68AC, #68BC, #80BC, and #127AC. Tributaries of Brushy Creek are generally small and shallow with high-water channels 5-12 feet wide and sand-gravel bottoms. Because of visible iron hydroxides during February and March, the tributary to site #68 was believed to be influenced by an upstream gob pile previously covered with clay. This tributary was sampled at two locations (#68T and #67, see Appendix H), but only mean results were entered in computations characterizing tributaries of Brushy Creek. Tributary #125T received effluent from a large gob pile south of Harco and had substantial influence on Brushy Creek below the confluence. Therefore, data from #125BC and #125T were excluded from computations characterizing Brushy Creek and its tributaries, respectively.

Bankston Fork is somewhat larger and faster flowing than Brushy Creek. A sand-gravel bottom predominates, except at site #300, where siltation is substantial. The high-water channel width increases progressively from 16 feet at site #38 to 40 feet at site #300. From its origin 2.5 miles west of site #38, to the point where it crosses Route 13 south of site #174, Bankston Fork traverses predominately surface-mined land. Water at site #38 is actually overflow from an extensive system of mine pits immediately to the west. Tributaries of Bankston Fork had greater capacities than those of Brushy Creek, but only at site #144 was the water volume substantially greater. Also, siltation was generally greater at these tributaries. Of the Bankston Fork tributaries, site #136 was known to receive periodic overflow from a small strip pit to the northeast. Because atypical results were obtained at site #134 during August (Appendix I), these data were excluded from computations. These results are believed attributable

to suspended clay colloids originating from an upstream grading operation associated with the new Delta plant site development.

Water Level and Flow

Highest water levels and flow rates occurred during February-April; even the smallest tributaries carried water in February and March. Extensive rainfall during late February and March (Table 16) caused increases at all sites, particularly at sites #174 and #300, where depths in March were probably twice as great as in February. During April, water levels and flow rates were generally comparable to February, although those at sites #174 and #300 were judged somewhat greater. A consistent decrease was observed May-August; however, a strong continuity and flow were maintained on Bankston Fork. In May, site #80T entered the pool stage. During July and August, sites #32AC and #32BC on Brushy Creek were at the pool stage; continuity between downstream sites was tenuous and flow was barely perceptible. Sites #32T, #80T, and #127T were dry in July and August, while sites #134, #152, and the tributary to site #80 were in the pool stage. In September, a slight trend toward increased depth was observed, but the most marked effect was to reestablish and strengthen continuity along Brushy Creek. Although nearly 5.5 inches of rainfall were recorded at Harrisburg between the August and September collections (U. S. Dept. of Commerce, Environmental Data Service 1975), sites #32T, #80T, and #127T remained dry, and site #152 was still in the pool stage when visited in September.

Judging from rainfall data (Table 16), trends observed during this study were probably fairly typical. Exceptional rainfall occurred in March when peak water levels were observed, but a larger amount in August had little effect. Although continuity and flow are undoubtedly influenced

Table 16. Mean monthly air temperature, water temperature, and dissolved oxygen observed on the Delta expansion area, February-September 1975. (Respective Harrisburg average air temperature, precipitation, and long-term norms included for reference.)

	Air Temperature (°C)					Water Temperature (°C)[a]			Harrisburg Precipitation (in.)		Dissolved O_2 (ppm)[a]		
	Observed[a]			Harrisburg									
Month	$\bar{x}$	SD	(N)	Average[b]	Normal[c]	$\bar{x}$	SD	(N)	Total[b]	Normal[c]	$\bar{x}$	SD	(N)
Feb.	8	6.3	(24)	3.8	3.4	3	2.6	(24)	4.46	3.15	12.7	1.67	(24)
Mar.	15	2.8	(24)	6.2	8.0	11	1.2	(24)	7.85	4.72	10.3	0.51	(24)
April	19	3.6	(24)	13.8	14.8	15	2.2	(24)	4.72	4.28	9.2	0.73	(24)
May	25	1.7	(24)	21.4	19.6	21	2.3	(24)	3.39	4.82	6.6	1.44	(24)
June				24.8	24.3				1.45	3.91			
July	25	1.5	(21)	26.1	26.0	24	1.9	(21)	2.87	3.48	5.0	1.76	(21)
Aug.	26	2.9	(20)	29.3	25.2	24	1.8	(20)	8.75	3.56	4.5	2.08	(20)
Sept.	15	2.1	(21)	22.1	21.2	16	1.4	(21)	2.56	2.81	7.7	1.16	(21)

[a] Mean, estimated standard deviation (sample size).
[b] U. S. Dept. of Commerce, Environmental Data Service (1975).
[c] Calculated from U. S. Dept. of Commerce, Environmental Data Service (1974).

by rainfall, it seems probable that other factors are equally important. Low temperatures and plant dormancy probably promote high soil moisture and increased runoff during February-April; ground seepage into streams was frequently observed during these months and provided sustained input between periods of rainfall. High air temperatures and plant activity during summer months reduce soil moisture and runoff. Originally, Bankston Fork above site #174 was probably similar to Brushy Creek, with a tendency to form pools during the summer; however, the extensive strip pit to the west of site #38 now acts as a reservoir, providing sustained water during this period.

Air Temperature

Mean monthly air temperatures are presented in Table 16; the standard deviations reflect both diurnal and between-day variance. These temperatures were compared to monthly maximum, minimum, and average values at Harrisburg (U. S. Dept. of Commerce, Environmental Data Service 1975), but no consistent relationship was found. February-May temperatures were near the mean maxima reported by Harrisburg; however, July-September temperatures were nearest either the average or mean minima. Comparing mean daily temperature with respective Harrisburg data did not improve the relationship, although our measurements generally reflected Harrisburg average daily temperature. However, in February our measurements were closest to the daily maxima at Harrisburg; in August and September measurements were consistently less than the Harrisburg minima.

Water Temperature

Because as many as 5 hours elapsed between water temperature measurements, comparisons between sites are generally inappropriate. Therefore,

these data were grouped by month (Table 16). The extent to which the standard deviation reflects between-site differences or a diurnal cycle is not known, but variance was generally small compared to the mean of all sites. Mean water temperatures were 4-5°C less than mean air temperature during February-May; during July-September, the means differed by only 1-2°C. These trends possibly reflect changes in the rate and magnitude of diurnal air and water temperature cycles.

Dissolved Oxygen

Dissolved oxygen concentrations were inversely related to water temperature (Table 16). Concentrations were highest during February-April when lowest water temperatures and greatest flow rates occurred. Oxygen concentrations fell substantially during May-August when flow decreased and water temperature increased. The increase in September was probably the combined result of cooler water and increased flow. These data were not suitable for between-site comparison because oxygen saturation of water is markedly influenced by temperature. Therefore, all data were made independent of temperature by converting to percent saturation at measured water temperature (Table 17). Bankston Fork showed relatively slight fluctuations in percent oxygen saturation, probably because flow was well maintained. The large standard deviations during most months are attributable to water at site #38 becoming supersaturated as it overflowed the large strip pit to the west. In contrast, percent saturation on Brushy Creek decreased substantially during July and August when flow was virtually nonexistent; the large standard deviations reflect the tenuous continuity between sites. Some of this decrease and between-site variance may have been caused by net differences between oxygen consumed by respiration and produced by photosynthesis. A trend toward greater

Table 17. Monthly means and estimated standard deviations of water analyses by site category. (Alkalinity, acidity, and total hardness are reported as mg/l $CaCO_3$. Trace (tr) is a result not roundable to the smallest reported increment.)

Category	Sample Size	Dissolved O_2 (% Saturation)		pH		Alkalinity to pH 4.5	
		$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Brushy							
February	9	98	3.0	7.39	0.133	50	5.4
March	9	95	4.6	7.27	0.084	38	6.0
April	9	92	3.9	7.55	0.104	62	13.7
May	9	85	4.3	7.55	0.043	72	8.6
July	9	57	16.0	7.08	0.169	50	17.9
August	9	41	20.0	7.12	0.217	70	29.7
September	9	75	5.3	7.28	0.082	51	7.0
Bankston							
February	3	99	22.0	7.70	0.521	140	27.4
March	3	94	10.2	7.31	0.585	84	46.0
April	3	94	13.0	7.58	0.405	123	45.4
May	3	83	1.2	7.87	0.076	178	25.4
July	3	89	1.2	7.97	0.100	218	36.9
August	3	101	11.6	7.93	0.197	161	8.1
September	3	100	2.6	7.72	0.351	160	22.4
Brushy Tributaries							
February	5	96	3.7	7.08	0.302	50	29.2
March	5	92	5.7	6.96	0.178	35	18.0
April	5	89	6.5	7.15	0.267	50	21.3
May	5	54	21.0	6.99	0.398	75	35.9
July	2	59	9.9	7.20	0.056	85	12.7
August	2	65	7.1	7.31	0.028	92	21.9
September	2	79	0.0	7.53	0.385	103	30.8
Bankston Tributaries							
February	4	79	4.9	7.22	0.331	60	44.7
March	4	91	2.6	6.86	0.158	26	12.3
April	4	94	7.8	7.07	0.229	40	26.7
May	4	64	15.9	7.28	0.381	98	58.1
July	4	36	22.3	7.33	0.417	108	78.1
August	4	39	13.8	7.53	0.260	143	67.6
September	4	69	15.2	7.38	0.251	95	62.5

Table 17. Continued.

Category	Sample Size	Acidity to pH 8.2		Total Hardness		SO_4 (mg/l)	
		$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Brushy							
February	9	3.8	1.06	183	34.2	166	30.7
March	9	4.1	0.54	132	18.8	118	18.3
April	9	4.1	0.46	191	31.4	176	24.2
May	9	4.3	0.51	196	6.7	169	21.3
July	9	9.0	2.07	112	23.6	84	23.5
August	9	11.4	3.96	95	26.5	51	22.0
September	9	6.5	1.05	167	46.2	147	63.3
Bankston							
February	3	3.0	2.59	1130	151	1170	174
March	3	8.5	5.66	740	315	710	201
April	3	8.4	5.18	1100	135	1140	117
May	3	6.5	1.57	1680	35	1650	35
July	3	7.5	3.98	2320	133	2600	150
August	3	5.1	3.96	2300	338	2500	150
September	3	12.8	7.01	1800	488	1700	529
Brushy Tributaries							
February	5	6.5	1.98	210	99.9	197	83.5
March	5	6.8	1.98	146	69.2	122	61.8
April	5	7.8	3.41	214	125.1	206	122.7
May	5	16.5	9.97	291	194.5	283	202.3
July	2	11.8	1.70	390	16.3	359	26.5
August	2	12.2	1.98	466	5.0	407	14.1
September	2	10.8	8.52	530	129	449	171.1
Bankston Tributaries							
February	4	5.7	2.52	393	335.0	358	295.6
March	4	6.8	2.68	198	166.2	184	155.0
April	4	6.5	1.75	251	236.6	230	229.1
May	4	11.4	3.12	530	474	448	404.1
July	4	11.6	2.23	550	826	520	852
August	4	10.9	0.79	940	894	820	773
September	4	11.1	3.59	570	691	392	441.8

Table 17. Continued.

Category	Sample Size	Total Fe (mg/l)		Mn (mg/l)		NO_3-N (mg/l)	
		$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Brushy							
February	9	0.39	0.048	0.55	0.230	0.5	0.18
March	9	0.79	0.221	0.29	0.149	0.4	0.11
April	9	0.40	0.283	0.22	0.062	0.2	0.10
May	9	0.16	0.031	0.15	0.039	0.1	0.12
July	9	1.7	1.04	0.43	0.337	0.1	0.16
August	9	1.9	1.96	1.6	1.27	tr	--
September	9	0.47	0.214	0.20	0.143	0.1	0.05
Bankston							
February	3	1.9	1.26	2.0	0.85	0.7	0.64
March	3	4.3	2.98	1.3	0.00	1.4	1.31
April	3	2.7	1.80	1.4	0.46	0.4	0.17
May	3	0.33	0.164	0.88	0.884	0.4	0.31
July	3	0.46	0.288	0.48	0.345	0.3	0.10
August	3	0.37	0.410	3.0	1.93	0.3	0.26
September	3	0.77	0.560	2.2	1.61	0.1	0.06
Brushy Tributaries							
February	5	0.53	0.494	1.0	1.72	0.5	0.44
March	5	1.1	0.70	0.61	1.059	0.6	0.30
April	5	0.46	0.300	0.98	1.559	0.3	0.18
May	5	0.61	0.803	2.4	3.07	0.2	0.16
July	2	0.28	0.078	1.0	0.90	tr	--
August	2	0.20	0.049	0.63	0.438	0.1	0.00
September	2	0.36	0.092	2.0	1.70	0.1	0.04
Bankston Tributaries							
February	4	0.45	0.445	1.8	2.06	0.1	0.08
March	4	4.5	7.79	0.67	0.761	0.2	0.17
April	4	0.60	0.533	0.88	0.963	tr	--
May	4	0.49	0.348	2.1	2.05	0.1	0.00
July	4	1.0	0.74	1.5	0.42	0.4	0.13
August	4	1.6	1.33	3.4	2.31	0.2	0.10
September	4	1.8	1.78	0.65	0.365	tr	--

Table 17. Continued.

Category	Sample Size	PO_4 (mg/l)		Turbidity (FTU)		Setteable Matter (ml/l)	
		$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Brushy							
February	9	0.04	0.029	8.5	1.89	tr	--
March	9	0.05	0.011	25	6.2	tr	--
April	9	0.05	0.011	14	8.4	tr	--
May	9	0.04	0.009	5.2	2.23	tr	--
July	9	0.07	0.030	50	23	tr	--
August	9	0.02	0.010	65	70	tr	--
September	9	0.04	0.010	9.3	6.39	tr	--
Bankston							
February	3	0.01	0.006	19	17.8	0.1	0.10
March	3	0.03	0.006	100	74	0.7	0.58
April	3	0.04	0.006	27	2.5	0.4	0.21
May	3	0.03	0.006	7.2	2.46	tr	--
July	3	0.03	0.010	6.9	0.78	tr	--
August	3	0.01	0.010	11	7.8	tr	--
September	3	0.02	0.010	3.8	2.80	tr	--
Brushy Tributaries							
February	5	0.03	0.013	8.4	4.81	0.1	0.17
March	5	0.03	0.021	50	58	0.1	0.13
April	5	0.05	0.011	13	8.6	tr	--
May	5	0.05	0.008	11	9.1	tr	--
July	2	0.07	0.014	5.6	0.57	tr	--
August	2	0.02	0.000	7.6	2.40	tr	--
September	2	0.02	0.007	3.0	3.78	tr	--
Bankston Tributaries							
February	4	0.02	0.013	7.6	5.74	tr	--
March	4	0.03	0.005	20	10.8	tr	--
April	4	0.06	0.025	8.3	1.67	tr	--
May	4	0.05	0.035	7.9	3.00	tr	--
July	4	0.06	0.061	25	14.2	0.1	0.04
August	4	0.05	0.070	25	8.5	0.1	0.11
September	4	0.05	0.045	45	76	tr	--

percent saturation in Brushy Creek was evident in September as continuity and flow were restored. Tributaries of both streams followed a trend similar to Brushy Creek, except the decrease in percent saturation became evident in May.

pH, Alkalinity, Acidity

In general, highest pH values on Brushy Creek occurred during February-May, with a mean of 7.44 during that period. The exception was a low of 7.27 in March (Table 17), believed attributable to dilution by extensive rainfall and rapid surface runoff; a trend for low concentrations during March will be apparent for many constituents measured during this study. Monthly means were lowest during July-September, ranging from 7.08-7.28 pH units. Except for a low of 38 mg/l in March, monthly alkalinity varied without pattern between 50-70 mg/l; an overall mean of 56 mg/l is probably representative. Monthly acidity during February-May was nearly constant at 3.8-4.3 mg/l (Table 17). Highest acidities were recorded during July and August when water levels were lowest. Increased flow during September was associated with a decrease in acidity.

Monthly pH on Bankston Fork was inversely related to water level, with highest results observed during July and August (Table 17). The yearly mean pH of Bankston Fork was 7.73, as compared to 7.32 for Brushy Creek. Site #38 always had the highest pH, and site #300 had the lowest (Appendix I). Alkalinity was also inversely related to water level (Table 17). Except in July, site #38 was always the most alkaline. The yearly mean alkalinity for Bankston Fork was nearly 100 mg/l greater than Brushy Creek. Monthly acidity on Bankston Fork did not follow a consistent pattern and varied from 3.0-12.8 mg/l (Table 17). Site #38 consistently

had the lowest acidity; site #300 had the greatest (Appendix I). Yearly mean acidity on Bankston was only 1.2 mg/l greater than Brushy Creek.

Tributaries of Brushy Creek and Bankston Fork showed similar patterns of change in pH, alkalinity, and acidity. Generally, lowest values were observed during February or March, with a progressive increase through August or September (Table 17). Mean acidity tended to be relatively stable during February-April; following an increase of several mg/l in May, concentrations tended to plateau. May was the month most tributaries suffered the greatest decrease in water level. Yearly mean pH of Bankston Fork tributaries was 7.23, as compared to 7.11 for those of Brushy Creek; tributaries of Bankston averaged 79 mg/l alkalinity and 9.1 mg/l acidity, as compared to 61 mg/l and 9.9 mg/l for tributaries of Brushy.

Total Hardness and Sulfate

There was a close relationship in magnitude and seasonal change between total hardness and sulfate (Table 17); thus, results for these are discussed together. The reason for this similarity is not known, but the correlation is not due to chemical interference during analysis.

Although concentrations in Brushy Creek decreased during March, probably because of heavy rainfall and concomitant rapid surface runoff, highest total hardness and sulfate levels tended to occur during February-May (Table 17). Lowest concentrations were associated with lowest water levels in July and August. Total hardness and sulfate increased in September as flow was reestablished and water levels increased. Thus, the overall pattern of change was to some extent directly related to water level. No consistent downstream trends were apparent, and no single site consistently had extreme concentrations (Appendix I). Brushy Creek averaged 154 mg/l total hardness and 130 mg/l sulfate during the year.

In contrast, concentrations in Bankston Fork changed inversely with water level and were always substantially greater than in Brushy Creek (Table 17). The March means of 740 mg/1 total hardness and 710 mg/1 sulfate were primarily attributable to low concentrations at sites #174 and #300. A progressive downstream decrease in concentration (Appendix I) supports the concept of dilution during this month, as sites #174 and #300 showed the greatest increases in water level. For all months but September, total hardness and sulfate concentrations of Bankston Fork were primarily attributable to overflow from the strip pits west of site #38 (Appendix I). Comparison of results at sites #38 and #174 (Appendix I) reveals that the surface-mined area south of Route 13 generally caused only slightly increased concentrations. This contrasts markedly with results obtained for total iron and manganese. Bankston Fork averaged 1,580 mg/1 total hardness and 1,630 mg/1 sulfate during the year.

Except for a decrease during March, monthly means for tributaries of Brushy Creek increased progressively throughout the study (Table 17). However, this is possibly an artifact because only site #85 and the tributary to site #68 contained water during July-September; these sites averaged the highest concentrations during February-May. During the latter period, site #32T averaged less than 66 mg/1, while sites #80T and #127T averaged less than 185 mg/1. The tributary to site #68 (Appendix I, sites #67 and #68T) was generally highest in sulfate and hardness, but tributary #85 also tended to be high. During the year, tributaries of Brushy Creek averaged 265 mg/1 total hardness and 242 mg/1 sulfate.

Tributaries of Bankston were even more diverse, but monthly means followed a seasonal pattern roughly similar to the main stream (Table 17). Most of this apparent similarity is due to site #136, which always had the

highest concentrations (Appendix I). During February-May, this site averaged 770 mg/l total hardness and 690 mg/l sulfate, as compared to 1,760 mg/l and 1,480 mg/l, respectively, during July-September. Sites #134 and #152 were relatively low in both constituents, with results never exceeding 225 mg/l (Appendix I). Site #144 tended toward concentrations between sites #134 and #136, but this may have been coincidence during July and August, when continuity of flow was questionable. Tributaries of Bankston averaged 474 mg/l total hardness and 407 mg/l sulfate during the year.

Total Iron

Total iron concentrations in Bankston Fork reflected changes in water level and flow, with greatest means occurring during February-April and a high of 4.3 mg/l in March (Table 17). Mean total iron never exceeded 0.46 mg/l during May-August; the slight increase to 0.77 mg/l in September was associated with a corresponding increase in water level. A downstream increase in total iron was evident; lowest concentrations were always recorded at site #38, with a range of 0.07-0.98 mg/l (Appendix I). Site #174 consistently had higher concentrations than site #38, probably reflecting an acquisition of total iron as Bankston Fork flowed through the surface-mined area south of Route 13. Except during July, highest concentrations occurred at site #300, ranging from 0.47 mg/l in May to 6.8 mg/l in March (Appendix I). Much of the increase between sites #174 and #300 can be attributed to input from Brushy Creek (site #125BC, Table 18). Variation between sites of Bankston Fork was greatest during February-April when surface runoff was believed greatest. Monthly changes in total iron closely followed those of turbidity and settleable matter (Table 17), indicating that much of the detected iron was insoluble.

Table 18. Yearly mean results from sites #125AC, #125BC, and #125T. (Estimated standard deviations are in parentheses. Sample size is always 7. Alkalinity, acidity, and total hardness are reported as mg/1 $CaCO_3$.)

Site	O_2 (ppm)	pH	Alk.	Acidity	Total Hard.	Total Fe (mg/1)	Mn (mg/1)	SO_4 (mg/1)	NO_3-N (mg/1)	PO_4 (mg/1)	Turb. (FTU)	S.M.[a] (ml/1)
125AC	8.6	7.38	63	6.4	168	0.58	1.09	147	0.3	0.04	17	tr[b]
	(3.0)	(0.15)	(22)	(4.3)	(30.7)	(0.33)	(1.73)	(40)	(0.24)	(0.017)	(12.4)	--
125BC	8.2	4.50	12	314	317	47.6	6.9	630	5.5	0.05	32	0.8
	(2.0)	(1.90)	(18)	(352)	(156)	(49.5)	(7.7)	(491)	(7.1)	(0.045)	(40)	(1.5)
125T	8.3	2.82	0	1210	600	162	19	1800	13	0.22	39	1.2
	(3.3)	(0.45)	(0)	(1153)	(433)	(129)	(30)	(1474)	(10.7)	(0.31)	(37)	(1.6)

[a] Settleable matter.

[b] Trace, result not roundable to the smallest reported increment.

Overall, the seasonal change in total iron on Brushy Creek was opposite that of Bankston Fork, with low concentrations during February-May and highest values during July and August (Table 17). However, closer inspection reveals that the two streams underwent parallel changes during February-May, although monthly means in Bankston Fork averaged nearly five times those of Brushy Creek. During July and August, when water levels were low and Bankston Fork concentrations tended to be minimal, monthly means of Brushy Creek increased substantially to 1.7 mg/l and 1.9 mg/l, respectively (Table 17). Between-site variance was extreme during these months, especially in August, when a range of 0.10-6.2 mg/l was observed. There was a positive relationship between total iron concentration and turbidity (Appendix I); the highest turbidity (220 FTU) and greatest total iron (6.2 mg/l) occurred at site #68AC in August. In fact, the overall pattern of change in total iron was closely correlated with that of turbidity (Table 17). Both variables decreased sharply in September when water level and flow increased. The relationship between turbidity and total iron again suggests that much of the iron was insoluble. In contrast to Bankston Fork, total iron of Brushy Creek was unrelated to changes in settleable matter. During the year, Brushy Creek averaged 0.83 mg/l total iron, as compared to 1.6 mg/l for Bankston Fork.

Monthly means for tributaries of Bankston followed a pattern similar to Bankston Fork itself, with a peak occurring in March and lower concentrations thereafter (Table 17). However, a median value of 0.77 mg/l is more representative of March, because the mean was greatly influenced by a concentration of 16.2 mg/l at site #136 (Appendix I). The high concentration at site #136 is believed attributable to overflow from a small strip pit to the northeast; during July-September, iron concentrations

were conspicuously low (0.14-0.20 mg/l). In contrast, the remaining sites tended toward greater total iron concentrations during this period (Appendix I). The result of 62.3 mg/l at site #134 in August was excluded from the mean because it is clearly unusually high (Appendix I). The lower value of 4.2 mg/l in September was included, but both results seem atypical and are attributable to high turbidities caused by the grading operation referred to earlier.

Tributaries of Brushy Creek also had the highest mean concentration of iron during March (Table 17); all sites except #85 had the greatest total iron during this month (Appendix I). The tributary to site #68 averaged 1.4 mg/l during February and March when iron hydroxides were visible; thereafter, concentrations were never greater than 0.54 mg/l. Tributary #80T was relatively high in total iron, with a range of 0.59-1.1 mg/l during the 4 months it carried water. Except for site #127T in March and site #85 in May, a range of 0.15-0.49 mg/l was typical of tributaries #32T, #127T, and #85.

Manganese

Soluble manganese on Brushy Creek decreased consistently from 0.55 mg/l in February to 0.15 mg/l in May. A slight increase was evident in July, followed by a substantial peak of 1.6 mg/l in August. In September, concentrations decreased to a mean of 0.20 mg/l (Table 17). The July and August means were influenced slightly by respective concentrations of 1.3 mg/l and 4.9 mg/l at site #125AC (Appendix I); reasons for high values at this site will be discussed later. However, even if the value from #125AC is eliminated, an August mean of 1.24±0.378 mg/l is obtained. A definitive reason for this increase cannot be given; the solubility of manganese is a complicated phenomenon, dependent on slight changes in redox potential and

pH. However, manganese is known to be easily oxidized to insoluble forms which may later dissolve under appropriate conditions.

Monthly means in Bankston Fork followed a pattern of change which was parallel to that of Brushy Creek, but concentrations in Bankston were consistently higher (Table 17). During the year, Bankston Fork averaged 1.6 mg/l soluble manganese, as compared to 0.50 mg/l for Brushy Creek. Except in March, when all sites had a concentration of 1.3 mg/l, site #38 always had the lowest soluble manganese (Appendix I). The high mean for August is primarily attributable to concentrations of 4.4 mg/l and 3.7 mg/l at sites #174 and #300, respectively. Concentrations at site #174 were generally slighly higher than those at site #300.

Monthly means of Brushy tributaries were typically higher than those of Brushy Creek itself (Table 17), but this is primarily due to high concentrations in the tributary to site #68. Except for a low of 0.32 mg/l in a single pool during August, this tributary was consistently high in manganese, with a range of 1.4-8.0 mg/l (Appendix I). Site #80T had concentrations less than 0.60 mg/l only once during the 4 months it carried water; an extreme of 5.5 mg/l was recorded from a pool in May. Tributaries #32T, #127T, and #85 characteristically had low concentrations, with a range of 0.05-0.38 mg/l, excluding August and September values at site #85.

Tributaries of Bankston Fork were equally diverse. Except in September, site #136 consistently had manganese concentrations greater than 1.0 mg/l, with a high of 5.1 mg/l in May (Appendix I). Site #144 reflected the results at upstream sites #134 and #136 during all months except July and August when continuity of flow was questionable. Overall, sites #134, #144, and #152 tended toward concentrations less than 1.0 mg/l, except

during periods of low or nonexistent flow when concentrations were always greater than 1.0 mg/l.

Nitrate Nitrogen

Mean monthly nitrate nitrogen was generally higher in Bankston Fork than Brushy Creek (Table 17). Bankston averaged 0.5 mg/l during the year, as compared to 0.2 mg/l for Brushy Creek. Except for Bankston Fork in March, nitrate nitrogen concentrations of both streams gradually decreased throughout the study, with the greatest decrease between March and April. The high for Bankston Fork in March is attributable to a result of 2.9 mg/l at site #300 (Appendix I); the median of 0.8 mg/l is probably more representative.

Tributaries of Brushy showed a consistent decrease in nitrate nitrogen similar to Brushy Creek itself (Table 17). Mean concentrations of Bankston Fork tributaries ranged from 0.0-0.2 mg/l, except during July (Table 17), when all sites but #134 had the highest nitrate nitrogen concentrations during the study (Appendix I).

Orthophosphate

Orthophosphate concentrations in Brushy Creek were consistently higher than those of Bankston Fork (Table 17). Monthly concentration changes followed a similar pattern for both streams, except in July, when orthophosphate increased in Brushy Creek, but not in Bankston Fork. Low values were observed in both streams during February and August. The yearly mean concentrations of 0.04 mg/l for Brushy Creek and 0.02 mg/l for Bankston Fork are indicative of the differences between these streams.

Tributaries of Brushy Creek followed a pattern of change similar to Brushy Creek itself (Table 17). The mean concentration during the year

was 0.04 mg/1, identical to that of Brushy Creek. Mean orthophosphate concentrations for tributaries of Bankston Fork increased from a low of 0.02 mg/1 in February to a high of 0.05-0.06 mg/1 during April-September. However, results during July-September varied greatly between stations; site #134 had a concentration of 0.15 mg/1 in July and site #152 had concentrations of 0.13 mg/1 and 0.12 mg/1 in August and September, respectively (Appendix I). During the year, tributaries of Bankston Fork averaged 0.05 mg/1 orthophosphate.

Turbidity

Monthly turbidity in Bankston Fork varied directly with water level and flow. Greatest turbidities occurred during February-April (Table 17); the high of 100 FTU in March coincided with the greatest increase in water depth and was attributable to readings of 120 and 160 FTU at sites #174 and #300, respectively (Appendix I). Much of this turbidity was caused by the presence of iron hydroxides apparently acquired as Bankston Fork traversed the extensive surface-mined area south of Route 13. As water level and flow declined during May-September, mean turbidities decreased to 3.8-11 FTU (Table 17). On Bankston Fork, turbidity and settleable matter followed similar patterns of change.

During February-May, turbidity of Brushy Creek also varied directly with water level and flow, but the March increase was much less than observed in Bankston Fork (Table 17). However, turbidity increased substantially during July and August when water level and flow were lowest. Variation between sites was extreme in August with a range of 7.5-220 FTU, but only three sites had turbidities less than 26 FTU (Appendix I). During both months greatest turbidities were associated with sites identified

as having the greatest siltation. An increased water flow in September was associated with greatly reduced turbidity. In contrast to Bankston Fork, turbidity of Brushy Creek was unrelated to settleable matter.

Turbidity of Brushy Creek tributaries followed a seasonal change similar to Bankston Fork, with a high of 50 FTU observed during March and lowest turbidities observed July-September (Table 17). The mean in March was greatly influenced by a reading of 150 FTU at site #127T (Appendix I); the median of 27 FTU is more representative. Tributaries of Bankston Fork followed a pattern of change quite similar to that of Brushy Creek (Table 17). The apparent exception during September is due to a result of 160 FTU at site #134 (Appendix I), which was still somewhat influenced by the grading operation referred to earlier. Elimination of this result decreased the September mean to 3.0 FTU. The increased turbidity when water levels were low at sites with silty bottoms is perhaps attributable to wind promoting the mixing and suspension of bottom material.

Settleable Matter

Brushy Creek consistently averaged only trace amounts of settleable matter (Table 17); the highest observed value was 0.1 ml/l, which occurred at no site more than twice (Appendix I). Bankston Fork results seemed to follow a pattern reflecting water level. From a mean of 0.1 ml/l in February, settleable matter increased to 0.7 ml/l in March and decreased to 0.4 ml/l in April (Table 17). Sites #174 and #300 had the highest settleable matter during March and April (Appendix I); these sites also showed the greatest sustained increase in water depth as they received runoff from higher elevations. During May-September, settleable matter in Bankston Fork averaged only trace amounts.

Tributaries of Brushy Creek averaged trace amounts of settleable matter, except in February and March (Table 17). Results during these months were attributable to iron hydroxides present at sites #68T and #67 (Appendix I). Only during July and August did tributaries of Bankston Fork average more than traces of settleable matter (Table 17).

Sites #125BC and #125T

Sites #125BC and #125T were excluded from previous discussion because results were grossly atypical of Brushy Creek and Brushy tributaries, respectively. Tributary #125T is an obvious example of acid mine drainage (Table 18). A comparison of yearly means between sites #125AC and #125BC clearly indicates the impact of #125T on Brushy Creek; only dissolved oxygen and orthophosphate were not obviously affected. Except for manganese, means for site #125AC are closely representative of Brushy Creek in general. A temporary obstruction in June caused #125T to backflush #125AC; it is believed that manganese oxides were precipitated and later became soluble during July and August. Excluding results during these months yielded a mean manganese concentration of 0.28 mg/l, as compared to 0.50 mg/l for Brushy Creek during the year. Because of reduced dilution by #125AC and higher concentrations contributed by #125T, the affect on #125BC was greatest during July-September (Appendix I). Also, rather consistent differences in pH, alkalinity, acidity, total hardness, total iron, and sulfate between sites #174 and #300 appear attributable to #125BC. However, the differences tended to be small and relative water volumes must be considered.

Attempts to locate data which might be considered typical of the study area were unsuccessful. Although the greatest value of this research is a documentation of present stream characteristics, some generalizations seem appropriate.

In addition to the two tributaries already identified, two other potential sources of mine runoff are known for Brushy Creek; however, except for the segment below site #125, this stream seems relatively uninfluenced by mining activity. The hypothesis that high summer concentrations of manganese and total iron were caused by accumulated mine-waste precipitate is not substantiated as a similar pattern was observed in tributaries which apparently never carried mine runoff. Thus, the concentrations of manganese and total iron are probably a normal seasonal phenomenon associated with relative stagnation, low water levels, and local variation of stream bottom.

Water such as found at sites #125T and #125BC on Brushy Creek during the summer is of very poor quality and can be expected to have a profound negative effect on aquatic life, with only the most resistant species being capable of survival. Although Bankston Fork is definitely influenced by surface-mined land, the water is not acidic and its quality is substantially better than at sites #125T and #125BC. In this case, the influence on aquatic life may be more subtle, possibly indicated by an absence of sensitive species and a reduced species diversity. Although sulfate and hardness concentrations are high, the large strip pit on the west edge of the study area has possibly had a beneficial effect by promoting sustained flow during periods when Brushy Creek became stagnant. Most of the iron and manganese seemed attributable to surface-mined lands south of Route 13.

Data from site #136 and the tributary to site #68, both of which received periodic mine runoff, exemplify the difficulty in interpreting water sampling data. As judged by total iron concentration, the effect of the mine runoff seemed transitory and associated with maximum runoff; however, a sustained effect during minimum runoff was indicated by the manganese, sulfate, and total hardness concentrations.

B. Fishes of the Delta Expansion Area

On the basis of range and habitat requirements, 64 species of fish may be present in the Delta expansion area; 17 species were collected (Appendix J). Smith (1973) lists 186 species (28 families) of fish as presently occurring in Illinois; of these, 130 may occur in southern Illinois. Only one rare species, the bigeye shiner (Notropis boops Gilbert), is likely to occur in the study area (Lopinot and Smith 1973). This shiner has been recorded in southwestern and east-central Illinois.

The 17 species collected were all fishes common to the area and appeared to be well-distributed in available waters. Although sampling was limited to certain specific points, it is unlikely that additional sampling would reveal any unusual fish. In the spring sampling period, no fishes were observed at water sampling sites #125BC, #125T, and #136; these sites had pH values ranging from 2.93 to 7.33 and total iron concentrations of 1.37 mg/l to 79.60 mg/l (Table 19). No new species were found in the summer sampling; and, many of the sites were dry at that time.

Table 19. Number of fish species observed at each sampling site during the spring sampling period (18 April - 5 May 1975) in relation to some physical and chemical water parameters.

Sampling Site	No. of Fish Species	Water Temp. (°C)	Dissolved O_2 (ppm)	pH	Total Fe (mg/1)	Turbidity (FTU)
68 AC, BC, & T	4	17.3	9.0	7.59	0.22	7.5
67	2	17.2	8.3	7.36	0.42	7.5
80 AC & BC	3	17.3	8.5	7.63	0.22	7.1
127 BC	2	14.7	9.1	7.40	0.77	24.0
85	4	12.0	8.6	7.13	0.34	10.0
125 AC	3	14.0	9.3	7.42	0.80	24.0
125 BC	0	14.0	9.8	5.91	9.30	30.0
125 T	0	14.0	9.0	2.93	79.60	26.0
134	1	11.7	10.7	6.88	0.31	6.0
136	0	11.0	10.9	7.33	1.37	10.0
144	2	11.8	9.7	7.20	0.39	8.6
152	1	13.0	8.8	6.88	0.31	8.6
174	2	16.3	8.8	7.45	3.51	27.0
38	2	19.0	10.0	8.03	0.67	25.0
300	1	16.4	8.2	7.25	3.97	30.0

C. Aquatic Invertebrates of the Delta Expansion Area

Five major groups, or Phyla, of algae were collected at the stream sampling sites and the ponds: green algae (Chlorophyta), yellow-green algae (Chrysophyta), euglenoids (Euglenophyta), blue-green algae (Myxophyta), and dinoflagellates (Pyrrophyta). Seven Phyla of animals were represented by two classes of protozoans (Protozoa), two classes of rotifers (Rotatoria), one class of segmented worms (Annelida), one class of coelenterates (Coelenterata), one class of flatworms (Platyhelminthes), one class of mollusks (Mollusca), and three classes of joint-legged animals (Arthropoda). Appendix K lists all aquatic invertebrates found on the Delta expansion area; common names are given when possible.

For analysis, data were divided by plankton (microinvertebrates) and benthos (macroinvertebrates), by collection date, and by location (Tables 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, and 31). Plankton was recorded as number per liter and benthos as number per square foot. Collections were made in April and June in the ponds of the study area and in the Brushy Creek and Bankston Fork drainages within the study area.

The ecology of most aquatic invertebrates and their tolerance limits to variations in environmental parameters have been little studied. Generally, the extremes of variation, such as unpolluted versus heavily polluted waters, can normally be detected readily; but, the broader range of intermediate conditions include faunal variations that are hard to ascribe to any specific factor. Under these circumstances, and considering what is known with some certainty, it appears that the absence or rarity of certain groups, and the relative abundance of those that are present, are the useful biological indicators of water condition and quality. Obviously, the extent of collecting and the preservation techniques utilized may account for absence of some taxa.

Table 20. Plankton collected, Brushy Creek drainage, Delta expansion area, April 1975, by sampling site.

	Site #67		Site #68AC		Site #68T		Site #68BC		Site #80AC	
	No/1*	%	No/1	%	No/1	%	No/1	%	No/1	%
Bacillariophyceae										
Asterionella	0.8	0.6			8.0	2.6	0.4	1.6	60.8	9.7
Fragilaria			0.4	2.3	7.4	2.4	0.4	1.6	41.6	6.7
Gomphonema										
Gyrosigma										
Melosira	100.0	80.1	6.0	34.1	8.8	2.9	8.4	33.9	23.2	3.7
Navicula			0.4	2.3	55.6	18.3	8.4	33.9	69.6	11.2
Pinnularia	1.6	1.3	2.4	13.6	33.6	11.1	0.4	1.6	52.8	8.5
Synedra	4.8	3.8	1.6	9.1	168.0	55.4	5.2	21.0	345.6	55.4
Chlorophyceae										
Chaetophora							0.4	1.6	2.4	0.4
Cladophora	3.2	2.6	1.2	6.8	0.8	0.3			4.8	0.8
Closteriopsis			0.8	4.5					2.4	0.4
Closterium			0.8	4.5					2.4	0.4
Desmidium	0.8	0.6								
Spirogyra	0.8	0.6			0.8	0.3			0.8	0.1
Volvox	5.6	4.5	0.4	2.3	1.6	0.5				
Euglenophyceae										
Euglena					2.0	0.7				
Myxophyceae										
Anabaena	3.2	2.6			12.0	4.0	0.8	3.2	7.4	1.2
Protozoa										
Vorticellidae										
Tardigrada										
Rotifera										
Kellicottia			0.4	2.3						
Keratella cochlearis										
K. quadrata										
K. valga										
Notholca			1.6	9.1					2.4	0.4
Copepoda										
Nauplii	2.4	1.9	1.2	6.8	2.4	0.8			2.4	0.4
Cyclopidae	1.6	1.3	0.4	2.3	2.4	0.8	0.4	1.6	5.6	0.9
Cladocera										
Bosmina longirostris										
Chydorus sphaericus										
Leydigia quadrangularis										

*No/1 = number per liter; % = percent of all plankton collected at that sampling site.

Table 20. Continued.

	Site #80T		Site #80BC		Site #85		Site #125AC		Site 125T	
	No/l	%	No/l	%	No/l	%	No/l	%	No/l	%
Bacillariophyceae										
Asterionella	2.4	2.4	0.4	1.2	5.2	3.5				
Fragilaria					1.2	0.8				
Gomphonema					32.0	21.6				
Gyrosigma					0.8	0.5	0.4	1.4		
Melosira	36.0	36.0	1.2	3.5	16.8	11.4			0.8	5.4
Navicula			10.0	29.1	44.0	29.7	3.2	10.9		
Pinnularia	4.0	4.0	16.4	47.7	19.2	13.0	1.6	5.4	1.6	10.8
Synedra	40.0	40.0	1.6	4.7	12.0	8.1			0.8	5.4
Chlorophyceae										
Chaetophora			0.4	1.2						
Cladophora	4.0	4.0	0.8	2.3	0.4	0.3				
Closteriopsis			0.4	1.2						
Closterium	2.4	2.4	0.8	2.3	2.8	1.9	0.4	1.4		
Desmidium										
Spirogyra			0.4	1.2					2.0	13.5
Volvox	1.6	1.6					1.2	4.1		
Euglenophyceae										
Euglena										
Myxophyceae										
Anabaena	3.2	3.2	1.2	3.5	6.0	4.1	14.0	47.6	9.2	62.2
Protozoa										
Vorticellidae							8.2	27.9		
Tardigrada										
Rotifera										
Kellicottia										
Keratella cochlearis	0.8	0.8			0.8	0.5				
K. quadrata										
K. valga										
Notholca			0.8	2.3						
Copepoda										
Nauplii	0.8	0.8			1.6	1.1				
Cyclopidae	4.0	4.0			3.2	2.2				
Cladocera										
Bosmina longirostris							0.4	1.4		
Chydorus sphaericus	0.8	0.8			2.0	1.4				
Leydigia quadrangularis									0.4	2.7

Table 20. Continued.

	Site #125BC		Site #127AC		Site #127T		Site #127BC	
	No/1	%	No/1	%	No/1	%	No/1	%
Bacillariophyceae								
Asterionella								
Fragilaria							0.4	1.1
Gomphonema							0.8	2.2
Gyrosigma	0.4	1.5						
Melosira	0.8	3.1	0.8	2.2	0.4	2.1	0.4	1.1
Navicula	0.8	3.1	0.8	2.2	1.6	8.5	12.0	32.3
Pinnularia					0.8	4.3	0.8	2.2
Synedra					0.4	2.1		
Chlorophyceae								
Chaetophora								
Cladophora					0.8	4.3	0.4	1.1
Closteriopsis			0.4	1.1				
Closterium								
Desmidium								
Spirogyra	0.8	3.1						
Volvox								
Euglenophyceae								
Euglena								
Myxophyceae								
Anabaena	20.0	76.9	23.2	63.0	14.8	78.7	11.2	30.1
Protozoa								
Vorticellidae			10.4	28.3			8.8	23.7
Tardigrada							0.4	1.1
Rotifera								
Kellicottia								
Keratella cochlearis	0.4	1.5					0.4	1.1
K. quadrata							0.4	1.1
K. valga	0.4	1.5						
Notholca								
Copepoda								
Nauplii	1.2	4.6	1.2	3.3			0.8	2.2
Cyclopidae	0.8	3.1					0.4	1.1
Cladocera								
Bosmina longirostris	0.4	1.5						
Chydorus sphaericus								
Leydigia quadrangularis								

Table 21. Plankton collected, Brushy Creek drainage, Delta expansion area, June 1975, by sampling site.

	Site #67		Site #68AC		Site #68T		Site #68BC		Site #80AC	
	No/1*	%	No/1	%	No/1	%	No/1	%	No/1	%
Bacillariophyceae										
Asterionella	0.8	0.8	0.4	0.1					0.4	0.1
Fragilaria									1.6	0.3
Gomphonema							0.4	0.1		
Gyrosigma	0.8	0.8	0.8	0.3	1.2	0.3			0.4	0.1
Melosira	0.8	0.8	19.2	7.0	1.2	0.3	5.2	1.5	244.8	48.5
Navicula			2.0	0.7			18.0	5.1	4.4	0.9
Pinnularia	7.2	6.9	2.4	0.9	14.8	3.7	3.2	0.9	0.8	0.1
Synedra	12.0	11.4	2.8	1.0	10.8	2.7	6.0	1.7	9.6	1.9
Chlorophyceae										
Closterium	9.6	9.2	2.0	0.8						
Mougeotia	4.0	3.8	0.4	0.1						
Spirogyra					0.4	0.1			2.4	0.5
Tetraedron									0.8	0.1
Treubaria					0.4	0.1			0.4	0.1
Myxophyceae										
Anabaena	66.4	63.3	230.8	83.7	366.8	91.8	318.4	89.6	232.4	46.1
Protozoa										
Vorticellidae	0.8	0.8							0.4	0.1
Rotifera										
Lecane	1.6	1.5	0.8	0.3			0.4	0.1	0.4	0.1
Monostyla					2.4	0.6	0.4	0.1		
Copepoda										
Nauplii	0.8	0.8	2.8	1.0	0.4	0.1	2.0	0.6	0.3	0.1
Cyclopidae			2.4	0.9	0.8	0.2	0.4	0.1	4.0	0.8
Harpacticoida							0.4	0.1		
Cladocera										
Chydorus			8.0	2.9			0.4	0.1	1.2	0.2
Scapholeberis kingi										
Simocephalus					0.4	0.1				
Pleuroxus denticulatus			0.4	0.1						

*No/1 = number per liter; % = percent of all plankton collected at that sampling point.

Table 21. Continued.

	Site #80T		Site #80BC		Site #85		Site #125AC		Site #125T	
	No/1	%	No/1	%	No/1	%	No/1	%	No/1	%
Bacillariophyceae										
Asterionella					14.0	0.8				
Cymbella					10.0	0.6				
Fragilaria							0.8	0.2	0.4	0.4
Gomphonema					124.0	7.2				
Gyrosigma					18.0	1.0	6.8	1.9		
Melosira			30.8	10.4	794.0	45.9	195.2	55.8	16.0	13.6
Navicula					22.0	1.3	10.4	3.0		
Pinnularia			4.4	1.6	142.0	8.2	38.4	11.0	0.8	0.7
Stauroneis							11.6	3.3		
Synedra			8.8	3.0	336.0	19.4	32.0	9.1	1.2	1.0
Chlorophyceae										
Cladophora					2.0	0.1				
Closterium					10.0	0.6	0.4	0.1		
Spirogyra			1.2	0.4	*		2.4	0.9	0.4	0.4
Treubaria			0.4	0.1						
Euglenophyceae										
Euglena					4.0	0.2				
Myxophyceae										
Anabaena			249.6	84.1	180.0	10.4	28.4	8.1	98.8	84.0
Rotifera										
Bdelloida					4.0	0.2	0.4	0.1		
Monogononta										
Lecane							0.4	0.1		
Monostyla							0.4	0.1		
Copepoda										
nauplii			0.8	0.3	6.0	0.3	10.8	3.1		
Cyclopidae					12.0	0.7	10.4	3.0		
Cladocera										
Alona					10.0	0.6	0.4	0.1		
Chydorus			0.4	0.1	40.0	2.3	0.8	0.2		

* greater than 1500 per liter not in % column totals

Table 21. Continued.

	Site #125BC		Site #127AC		Site #127T		Site #127BC	
	No/1	%	No/1	%	No/1	%	No/1	%
Bacillariophyceae								
Asterionella			4.8	0.7			22.0	2.7
Cymbella			1.6	0.2			6.0	0.7
Gomphonema			0.8	0.1			6.0	0.7
Gyrosigma			24.8	3.8			2.0	0.2
Melosira	4.4	4.1	387.2	59.8			180.0	21.9
Navicula	0.4	0.3	49.6	7.7			192.0	23.3
Pinnularia	3.2	2.7	10.4	1.6			86.0	10.4
Synedra	2.4	2.0	52.0	8.0			298.0	36.2
Fragilaria							6.0	0.7
Chlorophyceae								
Closterium			1.6	0.2				
Spirogyra			29.6	4.6			**	
Myxophyceae								
Anabaena	106.0	90.7	62.4	9.6			10.8	1.3
Rotifera								
Lecane			0.8	0.1				
Monostyla							2.0	0.2
Copepoda								
Nauplii			8.0	1.2			4.0	0.5
Cyclopidae			3.2	0.5			2.0	0.2
Cladocera								
Chydorus			5.6	0.8			6.0	0.7
Pleuroxus denticulatus			1.6	0.2				
Scapholeberis kingi			3.2	0.4				

** greater than 1500 per liter so not included in total percent calculations

Table 22. Benthos collected, Brushy Creek drainage, Delta expansion area, April 1975, by sampling site.

	Site #67		Site #68AC		Site #68T		Site #68BC		Site #80AC	
	No/ft^2*	%	No/ft^2	%	No/ft^2	%	No/ft^2	%	No/ft^2	%
Oligochaeta										
Lumbriculidae					0.3	50.0				
Tubificidae										
Limnodrilus									0.3	3.0
Crustacea										
Amphipoda										
Crangonyx							0.3	25.0		
Isopoda										
Asellus										
intermedius			0.7	33.3			1.0	75.0	1.3	12.1
Insecta										
Coleoptera										
Tanymecus	0.3	25.0								
Diptera										
Chironomidae										
Chironominae										
Cryptochironomus									0.3	3.0
Paralauterborniella			0.7	33.3						
Polypedilum									6.7	60.6
Orthocladiinae										
Orthocladius			0.7	33.3					1.7	15.2

*No/ft^2 = number per square foot; % = percent of all benthos collected at that sampling site.

Table 22. Continued.

	Site #67		Site #68AC		Site #68T		Site #68BC		Site #80AC	
	No/ft^2	%	No/ft^2	%	No/ft^2	%	No/ft^2	%	No/ft^2	%
Insecta										
Diptera										
Empididae										
Empis	0.3	25.0								
Ephemeroptera										
Ameletus					0.3	50.0				
Caenis									0.3	3.0
Hemiptera										
Gerridae										
Gerris	0.3	25.0								
Plecoptera										
Isoperla decepta									0.3	3.0
Nemoura	0.3	25.0								

Table 22. Continued.

	Site #80T		Site #80BC		Site #125AC		Site #125T		Site #125BC	
	No/ft^2	%	No/ft^2	%	No/ft^2	%	No/ft^2	%	No/ft^2	%
Insecta										
Diptera										
Simuliidae									0.3	4.2
Tipulidae										
Tipula					0.3	4.5				
Ephemeroptera										
Ameletus			0.7	12.5						
Caenis			0.3	6.3	1.0	13.6			1.3	16.7
Pseudocloeon					0.3	4.5			0.7	8.3
Hymenoptera										
Camponotus									0.3	4.2
Lepidoptera							0.3	100		
Odonata										
Cordulegaster	0.3	3.3								
Plecoptera										
Isoperla decepta					0.7	9.1			0.3	4.2
Nemoura	0.7	6.7			0.7	9.1			1.3	16.7
Perlesta placida					0.3	4.5				
Crustacea										
Amphipoda										
Crangonyx	2.3	23.3								
Decapoda										
Orconectes									0.3	4.2
Isopoda										
Asellus intermedius	3.0	30.0	0.3	6.3	2.3	31.8			2.7	33.3
Lirceus fontinalis	3.0	30.0	0.3	6.3	0.7	9.1			0.7	8.3
Insecta										
Diptera										
Chironomidae										
Chironominae										
Cryptochironomus					1.0	13.6				
Glyptotendipes	0.3	3.3								
Polypedilum			1.7	31.3						
Orthocladiinae										
Orthocladius			2.0	37.5						
Tanypodinae										
Pentaneurini	0.3	3.3								

Table 22. Continued.

	Site #85		Site #127AC		Site #127T		Site #127BC	
	No/ft^2	%	No/ft^2	%	No/ft^2	%	No/ft^2	%
Oligochaeta								
Tubificidae								
Limnodrilus	0.3	0.8			1.3	2.3		
Peloscolex					0.3	0.6		
Arachnida								
Linyphiidae			0.3	2.1				
Crustacea								
Isopoda								
Asellus intermedius	12.0	27.1	5.0	31.9	30.7	52.9	2.7	20.5
Lirceus fontinalis	3.3	7.5	3.3	21.3	23.3	40.2	1.0	7.7
Insecta								
Coleoptera								
Anthicidae							0.3	2.6
Dytiscidae	0.7	1.5						
Diptera								
Ceratopogonidae	0.3	0.8						
Chironomidae	0.3	0.8						
Chironominae								
Chironomus	0.3	0.8						
Microtendipes	0.3	0.8						
Tanytarsini	0.3	0.8	0.3	2.1				
Orthocladiinae			0.3	2.1				
Corynoneura	0.3	0.8						
Orthocladius	1.3	2.3						
Psectrocladius					1.0	1.7		
Tanypodinae	0.3	0.8						
Pentaneurini	0.3	0.8						

Table 22. Continued.

	Site #85		Site #127AC		Site #127T		Site #127BC	
	No/ft^2	%	No/ft^2	%	No/ft^2	%	No/ft^2	%
Insecta								
Diptera								
Empididae								
Empis	0.7	1.5						
Simuliidae			0.3	2.1				
Simulium					0.3	0.6		
Tabanidae								
Tabanus			0.3	2.1				
Tipulidae								
Pseudolimnophila	1.7	3.8						
Ephemeroptera								
Caenis	2.0	4.5	2.3	14.9				
Heptagenia	0.3	0.8			0.3	0.6	0.7	5.1
Paraleptophlebia	0.7	1.5						
Pseudocloeon	0.7	1.5	1.0	6.4			3.7	28.2
Stenonema			0.3	2.1				
Hemiptera								
Miridae	0.3	0.8						
Homoptera								
Aphididae					0.3	0.6		
Hymenoptera								
Crematogaster							0.3	2.6
Plecoptera								
Isoperla decepta	7.7	17.3					1.3	10.3
Nemoura	6.3	14.3	1.7	10.6	0.3	0.6	1.7	12.8
Perlesta placida	0.3	0.8	0.3	2.1			1.3	10.3
Trichoptera								
Polycentropus	1.0	2.3						
Rhyacophila	2.3	5.3						

Table 23. Benthos collected, Brushy Creek drainage, Delta expansion area, June 1975, by sampling site.

	Site #67		Site #68AC		Site #68T		Site #68BC		Site #80AC	
	No/ft^{2*}	%	No/ft^2	%	No/ft^2	%	No/ft^2	%	No/ft^2	%
Crustacea										
Isopoda										
Asellus forbesi			1.3	8.3	0.3	12.5	2.0	13.3		
Insecta										
Coleoptera										
Dubiraphia									0.3	0.9
Hydroporus									0.3	0.9
Diptera										
Chironomidae										
Cricotopus					0.3	12.5	0.7	4.4		
Cryptochironomus			2.0	12.5			1.0	6.7	0.7	1.9
Dicrotendipes									0.3	0.9
Einfeldia					0.3	12.5	1.7	11.1		
Polypedilum			4.7	29.2	1.0	37.5	2.3	15.6		
Procladius	0.3	20.0	2.7	16.6			1.7	11.1	7.3	20.8
Pseudochironomus			5.0	31.3						
Stictochironomus									17.7	50.0
Pentaneurini					0.3	12.5	4.0	26.7		
Tanytarsini	0.3	20.0					0.3	2.2	8.7	24.5
Paracladopelma	0.3	20.0					0.7	4.4		
Xenochironomus							0.3	2.2		
Ephemeroptera										
Epeorus							0.3	2.2		
Hemiptera										
Corixidae	0.3	20.0								
Gerridae										
Trepobates	0.3	20.0								
Trichoptera										
Ptilostomis			0.3	2.1						
Cheumatopsyche					0.3	12.5				

*No/ft^2 = number per square foot; % = percent of all benthos collected at that sampling site.

Table 23. Continued.

	Site #80T		Site #80BC		Site #85		Site #125AC		Site #125T	
	No/ft^2	%	No/ft^2	%	No/ft^2	%	No/ft^2	%	No/ft^2	%
Oligochaeta										
Ophidonais							0.3	0.9		
Crustacea										
Decapoda										
Orconectes					0.3	1.4				
Isopoda										
Asellus					2.3	9.7	7.3	18.8		
Insecta										
Coleoptera										
Bidessus					0.3	1.4				
Diptera										
Chironomidae										
Coelutanypus							1.3	3.4	0.3	50.0
Cryptochironomus			1.0	13.6	1.0	4.2				
Diplocladius							0.3	0.9		
Einfeldia							1.0	2.6		
Glyptotendipes							4.7	12.0		
Microtendipes					10.3	43.1				
Paracladopelma							0.3	0.9		
Polypedilum			1.3	18.2			1.7	4.3		
Procladius			3.0	40.9	0.3	1.4			0.3	50.0
Pseudochironomus			0.7	9.1						
Pentaneurini			1.0	13.6	1.7	6.9	3.0	7.7		
Tanytarsini					1.3	5.5	0.3	0.9		
Simuliidae							11.3	29.1		
Tipulidae										
Hexatoma							4.0	10.3		
Holorusia					0.3	1.4				
Pseudolimnophila					0.3	1.4				
Ephemeroptera										
Pseudocloeon							1.0	2.6		
Hemiptera										
Microvellia					2.0	8.3				
Trepobates					0.3	1.4				
Lepidoptera			0.3	4.5						
Megaloptera										
Sialis					0.7	2.8				
Trichoptera										
Cheumatopsyche					2.0	8.3	1.7	4.3		
Neureclipsis					0.3	1.4				
Gastropoda										
Physa					0.3	1.4				

Table 23. Continued.

	Site #125BC		Site #127AC		Site #127T		Site #127BC	
	No/ft^2	%	No/ft^2	%	No/ft^2	%	No/ft^2	%
Crustacea								
Decapoda								
Orconectes							1.3	1.5
Isopoda								
Asellus			1.3	9.1			1.3	1.5
Insecta								
Coleoptera								
Narpus							0.3	0.4
Diptera								
Chironomidae								
Chironomus	1.0	100.0						
Cricotopus			1.3	9.1			48.0	55.8
Cryptochironomus			1.7	11.4				
Microtendipes							0.7	0.8
Orthocladius			0.3	2.3				
Parachironomus			0.3	2.3				
Polypedilum			1.0	6.8			7.7	8.9
Procladius			1.3	9.1				
Stictochironomus			2.0	13.6				
Tribelos			0.3	2.3				
Trichocladius							0.3	0.4
Pentaneurini			1.3	9.1			5.7	6.6
Tanytarsini			0.7	4.5			3.7	4.3
Ceratopogonidae								
Palpomyia			0.3	2.3				
Culicidae								
Wyeomyia			0.3	2.3				
Empididae							0.7	0.8
Simuliidae			1.3	9.1			12.0	14.0
Tipulidae								
Hexatoma							0.3	0.4
Ephemeroptera								
Caenis			0.3	2.3				
Neocloeon			0.3	2.3			0.3	0.4
Pseudocloeon							1.3	1.5
Trichoptera								
Cheumatopsyche			0.3	2.3			2.3	2.7

Table 24. Plankton collected, Bankston Fork drainage, Delta expansion area, April 1975, by sampling site.

	Site #134		Site #136		Site #174		Site #300	
	No/1*	%	No/1	%	No/1	%	No/1	%
Bacillariophyceae								
Fragilaria			0.8	3.4			6.4	21.9
Gyrosigma					0.8	2.4		
Melosira	1.2	6.7	3.6	15.5	1.2	3.6	2.0	6.8
Navicula	8.8	48.9	9.6	41.4	5.2	15.5	6.0	20.5
Pinnularia	1.6	8.9						
Synedra					21.6	64.3	10.4	35.6
Chlorophyceae								
Desmidium			0.4	1.7			0.4	1.4
Spirogyra			0.4	1.7			0.8	2.7
Myxophyceae								
Anabaena	6.4	35.6	6.0	25.7	2.4	7.1	2.0	6.8
Protozoa								
Vorticella					1.2	3.6		
Rotifera								
Keratella quadrata			0.4	1.7				
Copepoda								
Nauplii			0.8	3.4	0.4	1.2	0.4	1.4
Cyclopidae			1.2	5.2	0.4	1.2	0.4	1.4
Cladocera								
Bosmina					0.4	1.2		
Daphnia							0.4	1.4

*No/1 = number per liter; % = percent of all plankton collected at that sampling site.

Table 25. Plankton collected, Bankston Fork drainage, Delta expansion area, June 1975, by sampling site.

	Site #134		Site #136		Site #174		Site #300	
	No/1*	%	No/1	%	No/1	%	No/1	%
Bacillariophyceae								
Cymbella	4.0	3.5						
Fragilaria	12.0	10.6					1.6	1.4
Gomphonema			38.4	18.6	1.6	0.5		
Gyrosigma	1.6	1.4	6.4	3.1	2.4	0.7		
Melosira			0.8	0.4	51.2	14.7		
Navicula	24.8	21.8	61.6	29.8	75.6	21.7	0.8	0.7
Pinnularia	29.6	26.1	28.8	13.9	23.2	6.7	2.0	1.7
Stauroneis	3.2	2.8					0.4	0.3
Synedra	12.8	11.3	48.0	23.3	141.6	40.7	108.8	93.8
Chlorophyceae								
Closterium	12.8	11.3	1.6	0.8	1.6	0.5		
Mougeotia	1.6	1.4						
Spirogyra	2.4	2.1			6.4	1.8	0.8	0.7
Myxophyceae								
Anabaena	6.4	5.6	16.8	8.1	0.8	0.2		
Rotifera								
Bdelloida					1.6	0.5		
Monogononta								
Lecane					7.2	2.1		
Monostyla					14.8	4.3		
Copepoda								
Nauplii	1.6	1.4	2.4	1.2	9.2	2.6	0.8	0.7
Cyclopidae	0.8	0.7	1.6	0.8	10.4	3.0	0.8	0.7

*No/1 = number per liter; % = percent of all plankton collected at that sampling site.

Table 26. Benthos collected, Bankston Fork drainage, Delta expansion area, April 1975, by sampling site.

	Site #134		Site #136		Site #174		Site #300	
	No/ft^{2*}	%	No/ft^{2}	%	No/ft^{2}	%	No/ft^{2}	%
Crustacea								
Amphipoda								
Crangonyx	1.3	19.0						
Decapoda								
Cambarus	0.7	9.5						
Isopoda								
Asellus								
intermedius	2.7	38.1			4.0	33.3		
Insecta								
Diptera								
Chironomidae								
Pentaneurini	0.3	4.8						
Tabanidae								
Tabanus	0.3	4.8						
Tipulidae								
Pseudolimnophila	0.3	4.8						
Stratiomyidae								
Hermione	0.3	4.8						
Ephemeroptera								
Pseudocloeon	0.7	9.5						
Odonata								
Dromogomphus					4.0	33.3		
Plecoptera								
Nemoura varshava					4.0	33.3		
Perlesta placida	0.3	4.8	0.3	100				

*No/ft^{2} = number per square foot; % = percent of all benthos collected at that sampling site.

Table 27. Benthos collected, Bankston Fork drainage, Delta expansion area, June 1975, by sampling site.

	Site #134		Site #136		Site #174		Site #300	
	No/ft^{2*}	%	No/ft^2	%	No/ft^2	%	No/ft^2	%
Oligochaeta								
Limnodrilus	0.3	0.5					0.7	33.3
Crustacea								
Amphipoda								
Crangonyx							0.3	16.7
Decapoda								
Orconectes	2.0	9.7						
Isopoda								
Asellus	11.7	56.4	4.3	18.6			1.0	50.0
Insecta								
Coleoptera								
Hydroporus			0.7	2.9				
Diptera								
Ceratopogonidae			0.3	1.4				
Chironomidae								
Chironomus			2.0	8.6				
Cryptochironomus			0.3	1.4				
Glyptotendipes			3.0	12.9				
Microtendipes	0.3	0.5						
Orthocladius					0.3	33.3		
Paratendipes			0.3	1.4				
Polypedilum			0.3	1.4				
Procladius			2.0	8.6				
Tribelos	1.0	4.8	0.7	2.9				
Pentaneurini			1.3	5.7				
Tanytarsini	3.3	16.1	3.3	14.3				
Simuliidae					0.3	33.3		
Ephemeroptera								
Neocloeon	2.0	9.7						
Hemiptera								
Corixidae			0.7	2.9				
Megaloptera								
Sialis			4.0	17.1				
Odonata								
Nehalennia					0.3	33.3		

*No/ft^2 = number per square foot; % = percent of all benthos collected at that sampling site.

Table 28. Plankton collected from the ponds of the Delta expansion area, April 1975.

	Pond 47		Pond 48		Pond 49		Pond 50	
	No/1*	%	No/1	%	No/1	%	No/1	%
Bacillariophyceae								
Cymbella			1034	2.3			345	4.7
Fragilaria	8	0.4	37928	84.5			345	4.7
Navicula	4	0.2	1379	3.1	1724	2.9	690	9.5
Rhoicospheria	4	0.2						
Rhopalodia							2069	28.5
Synedra	8	0.4	1379	3.1	12930	21.4	1379	19.0
Chrysophyceae								
Dinobryon	1756	93.0	1034	2.3				
Mallomonas	4	0.2						
Chlorophyceae								
Closterium			8	*			20	0.3
Desmidium			8	*	100	0.2	4	0.1
Gloeocystis			345	0.8				
Mougeotia	8	0.4	4	*	40514	67.2		
Oedogonia	8	0.4						
Pandorina					40	*		
Pediatrum			24	0.1			4	0.1
Pleurotaenium			16	*	10	*		
Sphaerocystis			345	0.8				
Spirogyra	12	0.6	1034	2.3	1724	2.9		
Volvox	4	0.2	64	0.1				
Zygnema							1724	23.7
Euglenophyceae								
Euglena	8	0.4						
Myxophyceae								
Anabaena					1724	2.9		
Lyngbya	4	0.2					345	4.7
Dinophyceae								
Ceratium							40	0.5
Protozoa								
Actinosphaerium					20	*		

*No/1 = number per liter; % = percent of all plankton collected at that pond.

Table 28. Continued.

	Pond 47		Pond 48		Pond 49		Pond 50	
	No/l	%	No/l	%	No/l	%	No/l	%
Oligochaeta								
Pristina			8	*				
Chaetogaster							4	*
Rotifera								
males?	8	0.4	4	*	10	*		
Keratella cochlearis			16	*			60	0.8
Lecane					80	0.1	4	*
Lepadella	4	0.2	24	*	20	*		
Monostyla			12	*	70	0.1	40	0.5
Platyias patulus					10	*		
Polyarthra			36	0.1				
Testudinella			4	*			12	0.2
Trichocerca			4	*	10	*	12	0.2
Crustacea								
Copepoda								
nauplii	48	2.5	40	0.1	650	1.1	92	1.3
Cyclopidae			40	0.1	130	0.2	28	0.4
Ostracoda			12	*				
Cladocera								
Alona			32	0.1	30	*	4	*
Chydorus			32	0.1	350	0.6	44	0.6
Daphnia					10	*		
Leydigia					10	*		
Insecta								
Chironomidae					20	*	4	*

*Less than 0.1% of total number.

Table 29. Plankton collected from the ponds of the Delta expansion area, June 1975.

	Pond 47		Pond 48		Pond 49		Pond 50	
	No/1*	%	No/1	%	No/1	%	No/1	%
Bacillariophyceae								
Cymbella			30	0.8	10	0.1	40	*
Fragilaria					20	0.1	130	0.1
Melosira	30	0.5			4310	33.3	10344	12.8
Navicula			140	3.9			30	*
Rhopalodia							60	*
Synedra	5172	81.9	120	3.4	2586	19.9		
Chlorophyceae								
Closterium	30	0.5	40	1.1			20	*
Cosmarium	10	0.1						
Desmidium					20	0.1		
Mougeotia	10	0.1			3448	26.6		
Pediastrum	10	0.1						
Pleurotaenium	20	0.3			10	0.1		
Oedogonia	20	0.3						
Spirogyra			70	2.0	20	0.1		
Euglenophyceae								
Euglena			20	0.6				
Phacus					20	0.1	30	*
Myxophyceae								
Anabaena	10	0.1	40	1.1				
Aphanocapsa	20	0.3						
Lyngbya					60	0.5	3448	4.3
Oscillatoria			630	17.7			862	1.1
Dinophyceae								
Ceratium	20	0.3	1220	34.4	1724	13.3	64650	80.3
Protozoa								
Actinosphaerium			30	0.8				

*No/1 = number per liter; % = percent of all plankton collected at that pond.

Table 29. Continued.

	Pond 47		Pond 48		Pond 49		Pond 50	
	No/l	%	No/l	%	No/l	%	No/l	%
Rotifera								
males?							20	*
Brachionus angularis			20	0.6			20	*
Keratella cochlearis	10	0.1	380	10.7	10	0.1	550	0.7
Lecane							10	*
Lepadella					10	0.1		
Monostyla			10	0.3			20	*
Platyias patulus			50	1.4	50	0.4		
P. quadricornis					20	0.1		
Polyarthra	30	0.5	50	1.4			30	*
Trichocerca	360	5.7	70	2.0			10	*
Crustacea								
Copepoda								
nauplii	430	6.8	90	2.5	190	1.5	170	0.2
Cylopidae	90	1.4	120	3.4	50	0.4	30	*
Diaptomidae								
Diaptomus			20	0.6				
Ostracoda					10	0.1	10	*
Cladocera								
Ceriodaphnia	20	0.3			370	2.8		
Chydorus sphaericus	10	0.1						
Bosmina longirostris			390	11.0	20	0.1	10	*
Insecta								
Ceratopogonidae							10	*
Chironomidae	10	0.1	10	0.3				

*Less than 0.1% of total number of organisms.

Table 30. Benthos collected from the ponds of the Delta expansion area, April 1975.

	Pond 47		Pond 48		Pond 49		Pond 50	
	No.	%	No.	%	No.	%	No.	%
Arachnida								
Arrenurus	1	0.4						
Crustacea								
Decapoda								
Orconectes							1	5.0
Isopoda								
Asellus					36	23.7		
Insecta								
Coleoptera								
Dytiscidae					1	0.7		
Bidessus			2	4.0				
Gyrinidae								
Peltodytes	2	0.8	4	8.0	1	0.7		
Hydrophilidae								
Hydrobius							1	5.0
Diptera								
Ceratopogonidae	120	46.7	1	2.0	14	9.2	2	10.0
Chironomidae								
Chironominae								
Chironomus			1	2.0	2	1.4		
Endochironomus	2	0.8	4	8.0			4	20.0
Microtendipes					1	0.7		
Polypedilum	4	1.5	3	6.0	4	2.6		
Pseudochironomus	19	7.4	2	4.0	54	35.5	4	20.0
Orthocladiinae								
Corynoneura					2	1.4		
Cricotopus			5	10.0	6	4.0		
Orthocladius	13	5.1						
Procladius	1	0.4						
Psectrocladius			4	8.0	8	5.3		
Tanypodinae	3	1.2	1	2.0	4	2.6		
Psectrotanypus			1	2.0				
Pentaneurini	51	20.0	15	30.0	4	2.6	4	20.0
Tabanidae								
Tabanus			1	2.0				
Ephemeroptera								
Caenis	26	10.1	1	2.0			1	5.0
Callibaetis	4	1.5						

Table 30. Continued.

	Pond 47		Pond 48		Pond 49		Pond 50	
	No.	%	No.	%	No.	%	No.	%
Insecta								
Odonata								
Celithemis	1	0.4						
Enallagma	5	1.9						
Erythemis	1	0.4						
Ischnura					1	0.7	3	15.0
Lestes	3	1.2						
Trichoptera								
Phryganeidae	1	0.4						
Gastropoda								
Physa			2	4.0				
Collembola								
Podura aquatica					6	3.9		

Table 31. Benthos collected from the ponds of the Delta expansion area, June 1975.

	Pond 47		Pond 48		Pond 49		Pond 50	
	No.	%	No.	%	No.	%	No.	%
Oligochaeta								
Limnodrilus	1	14.3						
Insecta								
Coleoptera								
Peltodytes			7	10.6				
Diptera								
Ceratopogonidae	1	14.3	15	22.7				
Chironomidae								
Chironomus					1	7.1		
Clinotanypus	2	28.6	13	19.7				
Endochironomus			2	3.0				
Glyptotendipes			5	7.6	7	50.0		
Kiefferulus					1	7.1		
Parachironomus	1	14.3			1	7.1		
Pentaneurini					1	7.1	5	16.1
Polypedilum			2	3.0	1	7.1	3	9.7
Procladius			2	3.0				
Tanypus			9	13.6				
Tanytarsini			2	3.0			18	58.1
Culicidae								
Chaoborus					1	7.1		
Tabanidae								
Chrysops			1	1.5				
Ephemeroptera								
Baetidae	1	14.3					1	3.2
Caenidae								
Caenis	1	14.3	1	1.5			2	6.4
Ephemeridae								
Hexagenia limbata			2	3.0				
Odonata								
Celithemis elisa					1	7.1		
Dromogomphus spinosa			1	1.5				
Enallagma			1	1.5			2	6.4
Libellula luctuosa			3	4.5				

Higher taxa which were completely absent from the samples included: Porifera (sponges), Nemertea (ribbon-worms), Gastrotricha (gastrotrichs), Nematoda (round-worms), Nematomorpha (horsehair-worms), Entoprocta (entoprocts), Bryozoa (bryozoans), and Pelecypoda (clams). Those that were rare, present in very low diversity, or both included: Protozoa, Coelenterata, Turbellaria, Tardigrada, and Gastropoda.

Although they may genuinely be uncommon at the sampling stations, the absence of Gastrotricha and Nematoda and the scarcity of Protozoa and Turbellaria in the samples could be accounted for solely by the collecting and preservation techniques employed. The Nemertea, Nematomorpha, and Entoprocta include only a handful of species of uncommon or sporadic occurrence in southern Illinois, so their absence is of no significance. Of the rare to absent groups, then, the higher taxa of some probable significance were the Porifera, Coelenterata, Bryozoa, Pelecypoda, and Gastropoda.

Siltation, scouring by heavy runoff, and low pH may be the factors accounting for the absence of sponges (Porifera). Turbidity and silt deposition have an adverse effect on most species of fresh-water sponges (Harrison 1974). Chemical factors of importance to sponges include calcium content of the water (Jewell 1939) and pH (Racek 1969). The high rate of runoff in the streams sampled in the Delta expansion area and the drying up of the upper parts of the streams in summer also significantly limit the amount of suitable habitat.

The only coelenterates to be expected in stream and pond habitats locally are a few species of Hydra. These tend to be missed in collecting unless they are present in rather large numbers. Such blooms locally appear to occur mostly in spring or fall in ponds, and in spring at lake

outfalls in streams, and may be of rather short duration. Their scarcity in the samples examined was probably due to a combination of factors which cannot be adequately assessed on the basis of available information.

Although little is known about the pollution ecology of the freshwater bryozoans (Bushnell 1974), these groups are probably limited by the factors cited for sponges. A few species are tolerant of a certain amount of turbidity, organic content, and oxygen depletion; but, heavy pollution of any kind seems to eliminate bryozoans rather quickly. The resistant statoblasts may permit recolonization when pollution is of short duration, but frequent intermittent pollution would exhaust the supply of statoblasts eventually. As they are comparatively sensitive to environmental disturbance, most species of bryozoans are pollution indicators more by their absence than their presence.

Certain environmental characteristics may be inferred on the basis of the absence or rarity of the clams (Pelecypoda) and the snails (Gastropoda). Both taxa are adversely affected by low pH, and even intermittent flushing of acid waters through the streams may be sufficient to eliminate or severely deplete their populations. Erosion of the shells is a characteristic response to acidity, and its presence in mollusks from a stream of pH 7 or above may indicate occasional periods of acidity. Food supplies, in the form of suspended organisms for the clams and plant material for many of the snails, must be present in both sufficient quantity and constant supply. Heavy runoff, which occurs periodically in the Delta expansion area, is not conducive to maintaining adequate food supply. The adverse effects of runoff may be somewhat alleviated locally by reduction of the stream to a series of pools in summer.

Availability of appropriate fish hosts for unionid clam glochidia (larvae) is another vital requirement for maintenance of the clam population. Factors that affect the fish population adversely will eventually show an effect on the clam fauna, whether the effect is a long-lasting one that leads to elimination of host fish, or an intermittent one that makes fish unavailable at the time glochidia are released.

The gravelly portions of the streams of the study area would normally be expected to support a fairly diverse mollusk fauna, but the streams are intermittent in these portions. Lower in the watershed, the amount of turbidity and siltation is likely to increase, and the number of stream mollusks tolerant of these conditions is low.

The higher taxa which were present in significant numbers in the ponds, streams, or both, included the Rotifera, Oligochaeta, and Arthropoda. The rotifers appeared mostly to be either those characteristic of lakes and slow streams or those with rather wide tolerances, although the euryoekous bdelloids were absent. There was some slight indication of acidity, perhaps, in the presence of Lecane and Monostyla, both genera which contain many acid water species, but other such genera (e.g., Cephalodella, Lepadella, and Trichocerca) were not found. Also, Brachionus was present, and most species of this genus are characteristic of alkaline waters. This combination suggests that the pH of the water is usually in the mid-range tolerated by both groups. Two rotifer species which are useful as indicators of different kinds of pollution were absent: Brachionus urceolaris, which may be the only metazoan animal present in highly acid water, and Trochosphaera solstitialis, which is usually uncommon but may become very abundant in water having a high organic content.

Fresh-water oligochaetes (earthworms), especially the tubificids, have traditionally been regarded as indicators of organic pollution. Again, other factors than the mere presence of a given species must be considered. The oligochaete data available from this study did not seem to indicate a significant level of organic pollution. Lumbriculids, naidids, and tubificids were all present, although not in abnormally large numbers. The lumbriculids and naidids tend to occupy stony streams and lake margins, while the tubificids may occur where the organic matter is sufficient to maintain a thick bacterial slime on the substrate (Brinkhurst and Cook 1974). In general, the quantity and quality of organic matter reaching the sediment appears to play a more dominant role in determining which tubificid species will be found in any given locality than do all of the commonly measured physical and chemical parameters of the water or the sediment.

The arthropods provide some additional clues to the water quality. The mite genus *Arrenurus*, almost totally absent from both stream and pond collecting stations, is especially characteristic of vegetation-filled ponds, lake margins, and stream backwaters. About 24 species are known from southern Illinois, and abundances of 20 per liter are not uncommon. Indications are that the sampling stations were low in productivity and standing crop of filamentous algae and rooted aquatics.

Amphipods and isopods of the genera reported probably feed mostly upon dead vegetation, largely leaves of deciduous trees. Their occasional abundance at some stations suggests that either there was sufficient organic matter present to support large populations of these animals, or the populations were aggregated. Such aggregation, or

clumping, might be due either to local accumulations of organic matter or to scarcity of suitable cover.

The crayfish fauna, although not large in either number of species or of individuals, suggests that the quality of the habitats was at least little worse than average. The genus *Orconectes*, in particular, is a non-burrowing type that lives more or less in the open on stream bottoms. This habit makes this crayfish much more susceptible to elimination by adverse conditions than *Procambarus* and *Cambarus*, which are occasional to regular burrowers. All crayfish, however, are susceptible to extirpation by stream channelization and to erosion of piled soil and rock into streams. These processes both eliminate the existing population and hinder recolonization (Hobbs and Hall 1974).

The entomostracan crustacean groups (seed shrimps, copepods, and water fleas) did not provide much information, except that their populations seemed rather low at most sites and times, suggesting low productivity of the habitats of the study area. In general, these crustaceans concentrate in areas of high organic content or in growths of filamentous algae or some higher aquatic plants. Peak populations are usually reached (except in the limnetic species) in ponds, lake shorelines, and stream backwaters, where living or dead plants are abundant.

A number of aquatic insects characteristic of cool, clear, relatively swift streams were absent. These included the beetles *Psephenus* and *Pelonomus* and most of the Illinois stoneflies (missing stonefly genera known from elsewhere in southern Illinois included *Leuctra*, *Allocapnia*, *Perlinella*, and *Acroneuria*).

The presence of the mayfly *Hexagenia limbata* suggests that prolonged oxygen depletion and fluidization of bottom sediments were not occurring

in sites where the species was taken. A few of the insects, such as the beetle Dubiraphia, the caddisfly Cheumatopsyche, and a number of the Diptera especially the Chironomidae, are known to be resistant to some types of pollution, but their mere presence does not demonstrate pollution. The presence of the black fly family (Simuliidae) and the caddisfly genus Rhyacophila suggest streams with fast currents (Ross 1944).

Overall, the aquatic insect fauna appeared abundant and of sufficient variation to suggest that the habitats sampled were relatively "normal" and probably were not suffering from most kinds of pollution, except, possibly, turbidity and siltation. Local areas apparently do suffer considerably from acid mine drainage, although this information was derived from descriptions of the collecting sites by others and not by inspection of the invertebrate samples. For the most part, the habitats of the Delta expansion area do not appear to be highly productive.

PART VI: IMPACTS OF SURFACE MINING

Initially, mining activities will destroy those animals not able to move from the area. Birds and the larger mammals will be absorbed by the surrounding habitats; most of the small rodents, amphibians, and reptiles will be eliminated.

On the study area, 3 plants, 5 mammals, 30 birds, and 4 amphibians and reptiles were considered rare or endangered; of these, 16 were actually found. All of the rare plants were found in forests; their reestablishment is unlikely. The largest white oak in the State of Illinois was located on the study area in Saline County (T 9S, R 5E, S 3). Although the loss of any one habitat type in the study area will not be crucial to any particular rare or endangered species, detrimental effects caused by the elimination of such a highly diverse area will be felt in the future, as such interspersion of habitats is the key to a diverse wildlife population. Of any single habitat, the loss of hedgerows may be the greatest in view of the current agricultural trend to eliminate hedgerows in order to increase crop production.

The number of species and the rate of their reestablishment on the Delta expansion area will depend largely on reclamation objectives and practices, and upon the rate of succession. Those areas reclaimed to row crops will be of limited use to wildlife; pastures will provide some habitat for small rodents and their predators. Surface mining of the study area will eventually be most detrimental to those animals associated with woodland, as forests take considerable time to reestablish. Numbers of species will remain low if the forests and pastures are planted to a single species; animals need a diverse shrub, as well as a tree layer.

The potential effects of surface mining on water quality are well documented. Of the factors monitored during this study, a decreased pH and an increased acidity, iron, manganese, sulfate, and total hardness are the frequent results. However, the magnitude and duration of changes are variable, and specific conditions at each mine probably greatly influence the impact on water quality. Important variables are: (1) the rapidity and extent of revegetation, (2) the degree to which streams are diverted around the mine, (3) the degree to which drainage is isolated within the mine, and (4) the chemical characteristics of the geologic material left exposed. It is evident that much can be done to ameliorate effects on water quality. Of the two mainstreams on the study area, Brushy Creek is relatively uninfluenced by mining activity, while Bankston Fork is already substantially affected. Because of low summer water volume, Brushy Creek would be disproportionately influenced by mine drainage. Therefore, every effort should be made to direct drainage away from Brushy Creek.

The full impact of surface mining on the aquatic plants and animals will be reflected in the extent to which streams are eliminated or at least modified. It is unlikely that sensitive forms, insofar as restrictiveness of habitat requirements is concerned, will become reestablished. Further, more tolerant forms may require an extensive period for reoccupying an area, depending, of course, on the availability of a suitable environment.

Finally, it is not that the study area is absolutely essential to the animals found there, or that the plants will grow nowhere else. The greater impact lies in the constant loss of natural habitat through mining, farming, and urban development. The loss of this 8,129 acres may be

insignificant now; but, when combined with the past and the future destruction of natural habitat, the impact on wildlife numbers and water quality may be tremendous.

PART VII: RECLAMATION ASPECTS

On the basis of soil quality and topography, much of the Delta expansion area is either unsuited or is marginal for many types of agricultural practices. Except for selected acreages, row-crop agriculture and other regular disturbances of the soil are not acceptable practices. Therefore, it is not expected that the Delta expansion area will be subjected to surface soil replacement and the 48-inch mantle of root growth media delineated in Section 6, subparagraph J of the Surface-Mine Land Conservation and Reclamation Act, P. A. 1568, and as amended (78-1295). The feasibility of afforestation and pasture and hay development is already successfully demonstrated by previous reclamation practices. The establishment of wildlife populations is contingent upon the types of habitats provided, the factor of time, and, generally, on the kinds of animals available for reinvasion of disturbed acreages. Only in the absence of revegetation practices will natural processes of plant species invasion, establishment, and succession occur; however, the latter is not possible because of required reclamation practices.

Predictions as to species of wildlife and time of invasion and establishment following current required reclamation can only be speculation. However, it can be safely assumed that much traditional reclamation will yield little diversity such as that created by variety in types of land use, stages of faunal and floral succession, patterns of topography, and designs of drainage pattern. Although planned reclamation can expand aquatic habitats as afforded by impoundments, little can be done to offset loss of stream or wetland habitats. Therefore, reclaimed acreages will

contribute less in habitats for a variety of fauna unless very special effort is made to create diversity. With shaping of shorelines, regulation of livestock access, planned vegetation of shoreline and littoral zones, and stocking with appropriate fishes, potentially productive sport fishery, furbearer habitat, and waterfowl habitat can be accomplished. With planned maximum aquatic development and distribution, incorporation of both "wildlife" grading (30 percent slope) and "pasture-meadow" grading (15 percent slope), field divider plantings, block plantings of appropriate trees, roadway locations and roadside plantings, and the selection of forage plants for pasture and hay which provide wildlife cover and food, habitats for wildlife diversity can be created which may potentially equal, if not exceed, that which occurred prior to mining.

Through planned subdivision and industrial development, potential economical returns from reclaimed areas may also exceed that prior to mining. Landscaping opportunities are challenging and unequalled, and shaping of the land can be encompassed in normal grading operations. Practices that can be incorporated in redesigning the affected acreages include the stockpiling and planning use of rock, maximizing distribution of water and shape of water bodies, designing access via roadways and trails, and emphasizing the minipark concept. Clearly there are opportunities for innovative reclamation which will provide the community acceptable and productive acreages. However, "prior use of the land" cannot and must not be any aspect of required or expected goals. Such massive disturbance of land should be viewed as a challenge to designers and landscape architects for new concepts of land shaping and of productive use.

PART VIII: SUMMARY AND CONCLUSIONS

AMAX Coal Company is planning to expand its Delta surface-mining activities in Williamson and Saline counties, Illinois. As mining operations will cause temporary, if not permanent, alteration of local terrestrial and aquatic environments, an inventory of the flora and fauna of the affected area and an assessment of the water quality were completed. The study included the period of October 1974 to December 1975; actual fieldwork covered three seasons from December through July, while water samples were collected February through September.

The primary objectives of the study were to: (1) describe and map the major soil types and land-use categories of the study area; (2) determine land-use trends; (3) assess present water quality; (4) identify and describe the principal habitat types; (5) inventory the plants, mammals, birds, amphibians, reptiles, fishes, and macroinvertebrates associated with each habitat; and (6) document the rare and endangered species of the study area. Secondarily, the impact of mining on wildlife and reclamation aspects were to be discussed.

Five general soil categories were identified on the study area: upland, bottomland, moderate slope, mixed, and terrace. Upland soil comprised about 58 percent of the study area, followed by bottomland soil at approximately 25 percent. In terms of crop yields, terrace soils were the most productive but occurred on only 3 percent of the study area. Most of the Delta expansion area was comprised of soils which had moderate to severe limitations for productive agricultural use which necessarily reduced the variety of cultivated crops grown, and required careful conservation

treatment. The major conservation measures required for cropland included controlling erosion, overcoming wetness and flooding, conserving moisture, and maintaining fertility.

Land-use maps were constructed for 1938, 1951-1952, and 1974. Ten land-use types were identified and mapped: cropland, pasture-old field, woodland, hedgerow, orchard, public road, railroad, buildings, surface-mined land, and water. Cropland, pasture-old field, and woodland were the major types of use comprising almost 92 percent of the total acreage over the 36-year period from 1938 to 1974. Acreage of the seven remaining land-use types remained relatively stable throughout the years at 8 percent. Over the 36 years, the Delta expansion area remained basically a rural agricultural area.

The main recreational activities of the 57 families resident to the study area were fishing, hunting, and picnicking. Use of the area by non-residents was limited. Most fishing trips were made to small farm ponds, with bluegill, bass, catfish, and crappie the major catch. Bobwhite quail was the most popular game bird in the study area; rabbits and squirrels were the most hunted game mammals. Nearly 50 percent of the residents picnicked on the study area.

A total of 411 plant species representing 88 families within nine habitat types (creeks and streams, creek forest, floodplain forest, lowland old field, pond and pond bank, upland forest, upland old field, hedgerows, and anthropogenic land) were recorded. Density, total basal area, and importance value of the tree layer species, density of the shrub layer, and cover value of the species of the herbaceous layer were utilized to determine the most important or dominant species in each habitat type.

As a result of fieldwork and literature surveys, a total of 354 animal species within 81 families were shown to occur or might be expected to occur in the Delta expansion area. Forty-four species of mammals in 16 families may occur in the study area; 29 species were actually trapped or observed. The number of mammals most frequently utilizing each habitat type were as follows: creeks and streams - 3; creek forest - 32; floodplain forest - 24; lowland old field - 24; pond and pond bank - 13; upland forest - 27; upland old field - 22; hedgerow - 21; and anthropogenic land - 17. The white-footed mouse was the most frequently captured small mammal; raccoon and white-tailed deer were the most frequently observed large mammals. Trapping success was greatest in hedgerows with 5.8 captures/100 trap-nights (TN), followed closely by creek forest with 5.6 captures/100 TN.

A total of 128 species and subspecies of birds was actually observed in the study area; an additional 124 species were expected to occur. Of these, 36 species may occur in creeks and streams habitat, 80 in creek forest, 93 in floodplain forest, 78 in lowland old field, 99 in pond and pond bank, 78 in upland forest, 64 in upland old field, 74 in hedgerows, and 69 in anthropogenic land.

Fifty-eight species and subspecies of amphibians and reptiles were expected to occur; of these, 31 were actually observed. The amphibians and reptiles were expected in the nine habitats as follows: creeks and streams - 30; creek forest - 38; floodplain forest - 35; lowland old field - 21; pond and pond bank - 36; upland forest - 22; upland old field - 15; hedgerow - 9; and anthropogenic land - 7.

Animal species in the study area considered rare or endangered in Illinois included 5 mammals, 30 birds, and 4 amphibians and reptiles;

in addition, 3 rare plants were found. None of the rare mammals, amphibians, or reptiles were sighted; the presence of 13 rare or endangered birds was verified.

Two major classes of terrestrial macroinvertebrates were collected in the study area: spiders and insects. Spiders were represented by 92 genera and species in 13 families; insects were represented by 443 genera in 136 families. Beetles, flies, and bees and wasps were the most abundant insect groups. The macroinvertebrates identified were those typically associated with these habitats in southern Illinois.

Water quality over most of Brushy Creek was generally good; however, as water level and flow decreased during the summer, total iron and manganese concentrations greater than 1.0 mg/l were observed. High total iron was associated with turbidity which was greater than 100 FTU at some sites. Approximately 0.75 miles before its confluence with Bankston Fork, the chemical characteristics of Brushy Creek were greatly altered by acid mine drainage; mean pH, total iron, and manganese during July-September were 2.75, 98.9 mg/l, and 15 mg/l, respectively. However, the effect on Bankston Fork was barely discernible, primarily because of water volume differences.

Bankston Fork was found to be substantially influenced by surface-mined lands, but the water was not acidic and generally had a mean pH greater than 7.50. Manganese and total iron concentrations greater than 1.0 were frequently observed; total hardness and sulfate were almost always greater than 1,000 mg/l. The former were primarily contributed by surface-mined lands south of Route 13, while the latter were present in overflow from a strip pit near the west edge of the study area. Seasonal trends were frequently different between Brushy Creek and Bankston Fork; these

were generally attributable to low summer water levels on Brushy and to probable qualitative differences in runoff received.

Tributaries of both streams were diverse. In addition to the tributary already noted, one tributary to each stream was identified as carrying mine runoff. Drainage from the entire new plant site was low in all measured constituents during February-May; unusual results obtained in August, and to a lesser extent in September, were attributable to runoff from a grading operation.

Seventeen species of fishes were collected from the hydrological sampling sites of the Delta expansion area; a total of 64 species may occur in the area. Only one rare fish, the bigeye shiner, is likely to occur.

The aquatic invertebrates of the study area were represented by five Phyla of algae and seven Phyla of animals. Green algae, blue-green algae, yellow-green algae, euglenoids, and dinoflagellates were present; the animals included protozoans, rotifers, segmented worms, coelenterates, flatworms, mollusks, and arthropods. Although the extent of collecting and the preservation techniques utilized may account for the absence of some taxa, the absence of sponges, bryozoans, and clams indicate the presence, at least periodically, of siltation, heavy runoff, and low pH in the Delta expansion area. The abundance of rotifers, earthworms, and arthropods at certain sampling sites suggested that the streams and ponds of the study area did not have high levels of organic pollution and provided relatively "normal" habitat for aquatic invertebrates in this area of southern Illinois.

At this writing, the Delta expansion area affords valuable wildlife habitat; and, it receives maximum utilization by most species. The area

contains a diversity of habitats, ranging over a variety of moisture regimes. In addition, there is relatively little human disturbance in the area. If succession were to continue and the area proceeded to climax forest vegetation, the wildlife value of the area would gradually decline. Certain species, of course, would remain abundant, but the loss of vegetative diversity will naturally result in decreased animal diversity.

Initially, mining activities will disrupt the successional trend and will destroy those animals not able to move from the area. Although the loss of any one habitat type in the study area will not be crucial to any particular species, the elimination of such a highly diverse area will eventually be reflected in the wildlife population. The number of species and the rate of their reestablishment on the Delta expansion area will depend largely on reclamation objectives and upon the rate of succession.

As far as wildlife is concerned, the most important reclamation program would be the development of a variety of habitats, interspersed throughout the area. The area can be planted to trees, preferably native species, and to pasture in randomly distributed blocks. For wildlife, it may be best to allow succession to proceed uninterrupted in the forested land; however, once a forest has been established, a harvest system for timber can be developed which also benefits wildlife. As the majority of the Delta expansion area is unsuited to farming or is "marginal" at best, the utilization of the area for wildlife and timber production in the future may be the most economical.

Through planned subdivision and industrial development, potential economical returns from reclaimed areas may exceed that prior to mining. Such massive disturbance of land offers unequalled opportunities to designers and landscape architects for developing new concepts of land shaping and of productive use.

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FIGURES

B

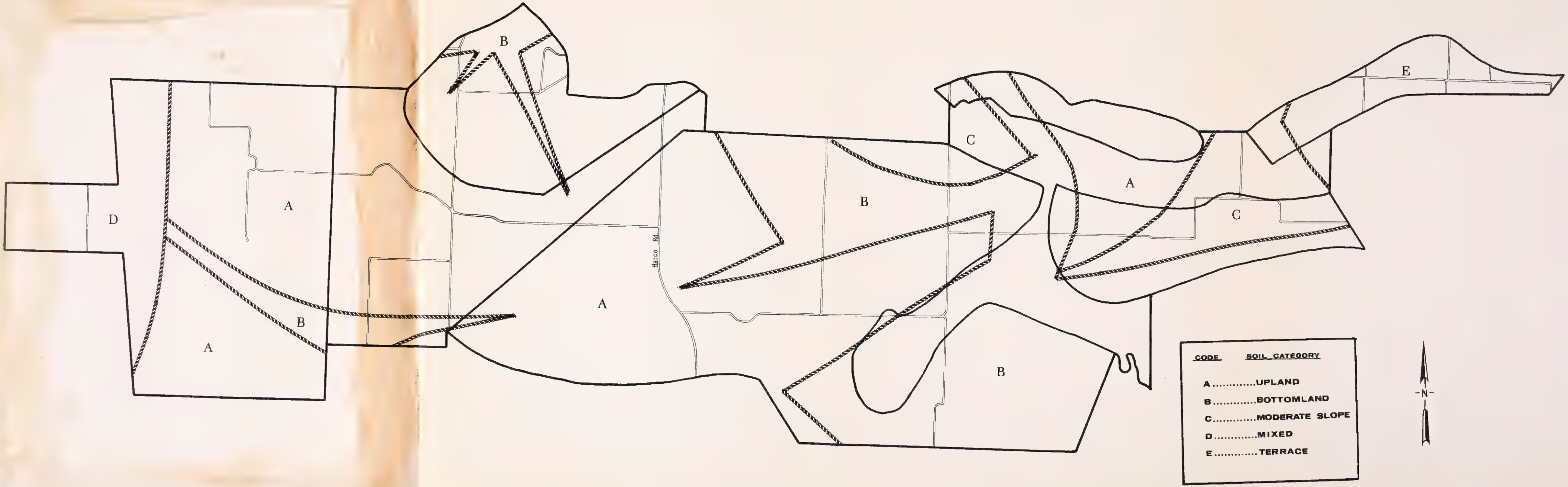
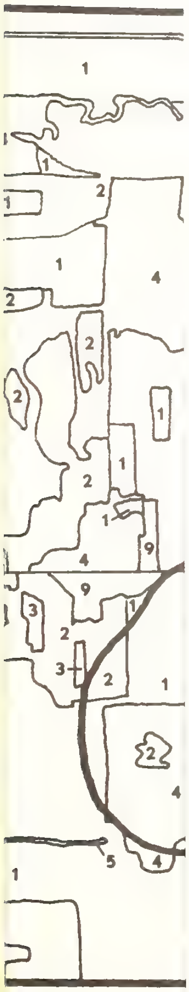


FIGURE 1. SOIL CATEGORIES OF THE DELTA EXPANSION AREA.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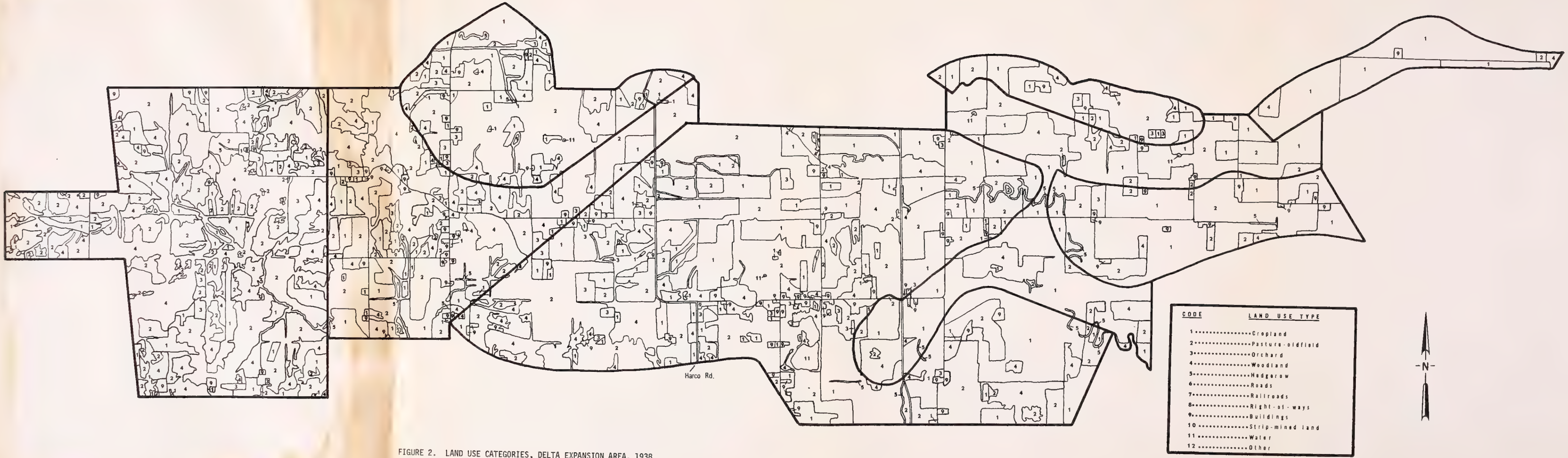
Harco Rd.
CODE
LAND USE TYPE
1 ....Cropland
2 ....Pasture-oldfield
3 ....Orchard
4 ....Woodland
5 ....Hedgerow
6 ....Roads
7 ....Railroads
8 ....Right-of-ways
9 ....Buildings
10 ....Strip-mined land
11 ....Water
12 ....Other
N

FIGURE 2. LAND USE CATEGORIES, DELTA EXPANSION AREA, 1938.

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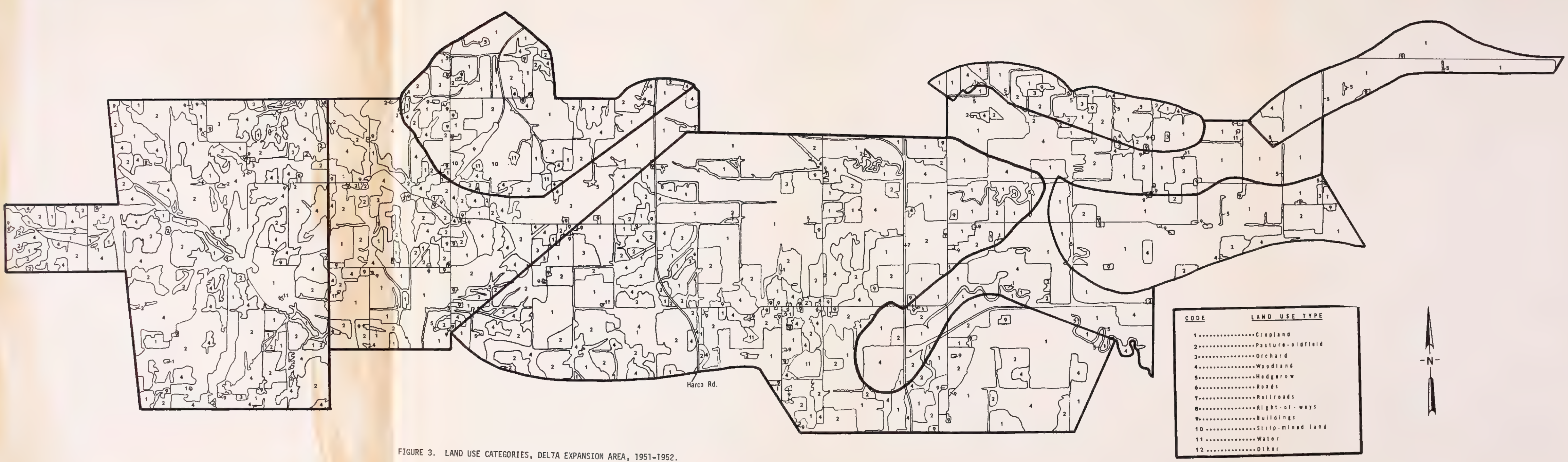
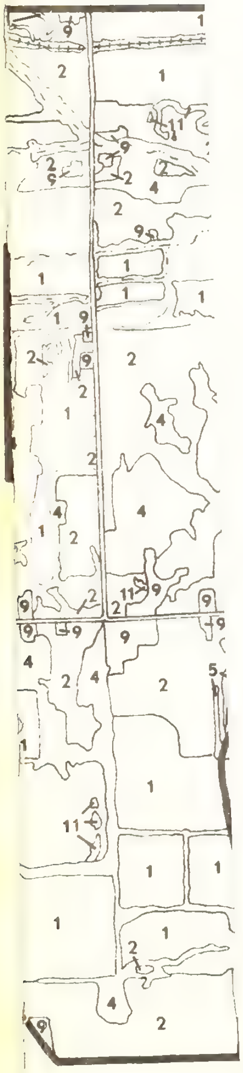

Harco Rd.
CODE
LAND USE TYPE
1 .... Cropland
2 .... Pasture-oldfield
3 .... Orchard
4 .... Woodland
5 .... Hedgerow
6 .... Roads
7 .... Railroads
8 .... Right-of-ways
9 .... Buildings
10 .... Strip-mined land
11 .... Water
12 .... Other
N

FIGURE 3. LAND USE CATEGORIES, DELTA EXPANSION AREA, 1951-1952.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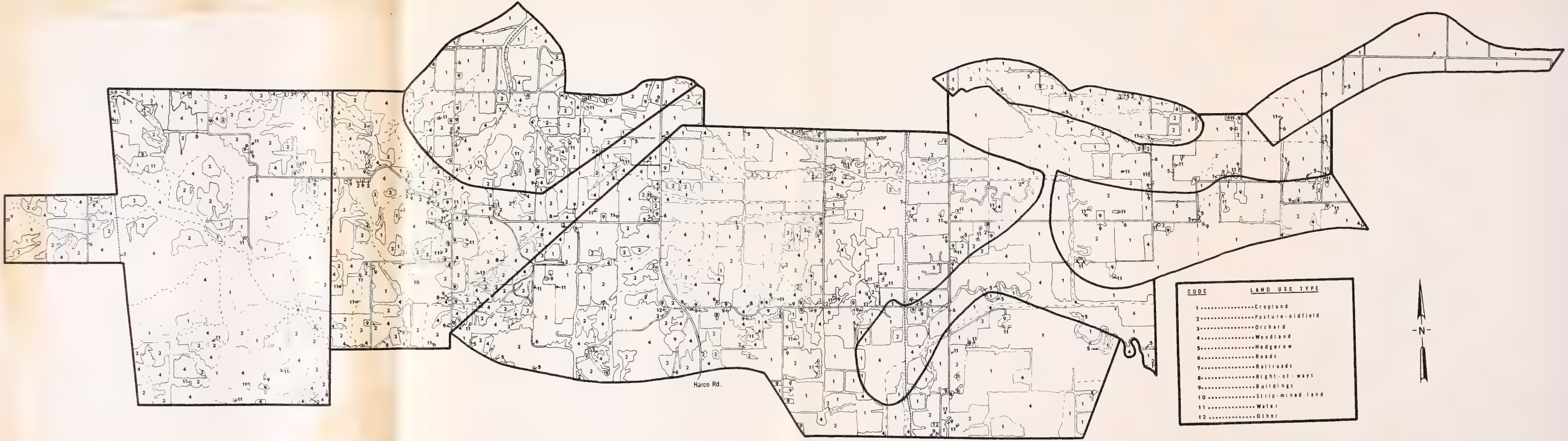

FIGURE 4. LAND USE CATEGORIES, DELTA EXPANSION AREA, 1974.

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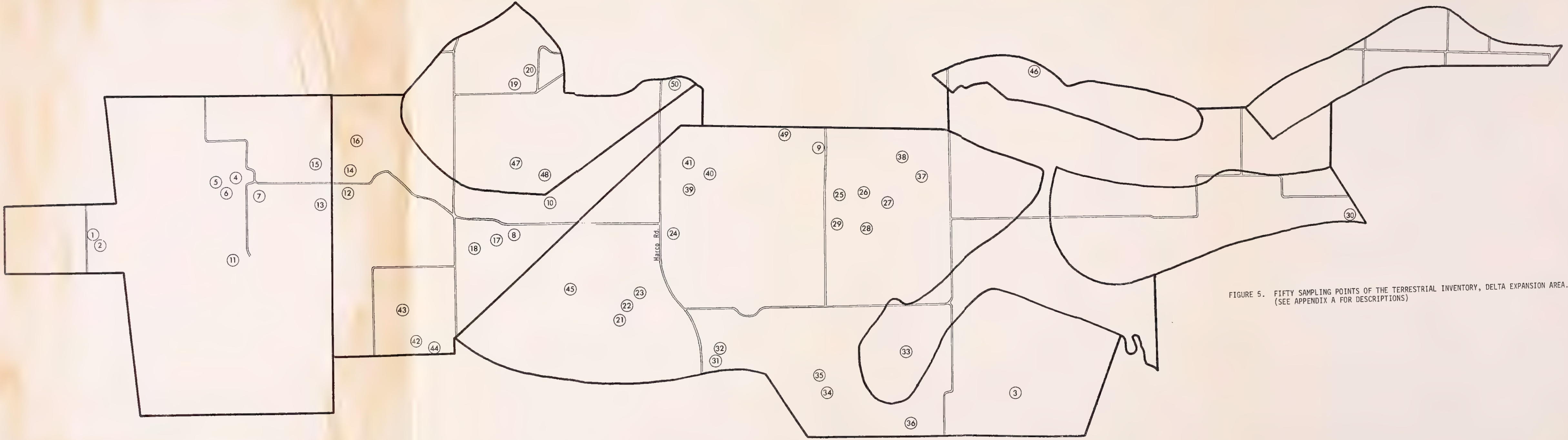

FIGURE 5. FIFTY SAMPLING POINTS OF THE TERRESTRIAL INVENTORY, DELTA EXPANSION AREA.
(SEE APPENDIX A FOR DESCRIPTIONS)

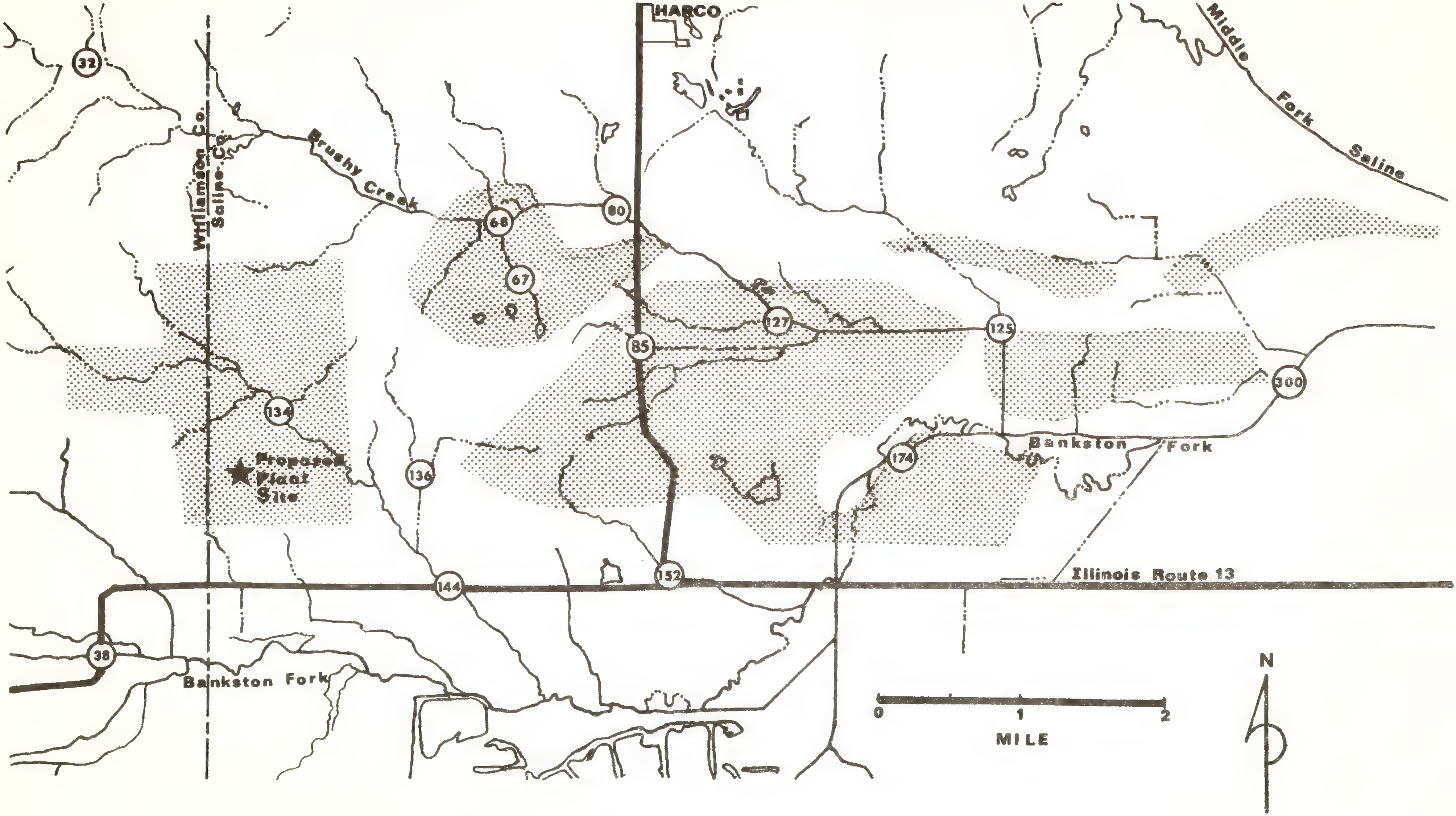

FIGURE 6. LOCATION OF STREAM WATER SAMPLING SITES. (AREAS TO BE MINED ARE STIPPLED.)

APPENDICES

APPENDIX A

Number and Habitat Type of the 50 Sampling Transects

Transect Number	Habitat Type
1	Lowland Old Field
2	Creek Forest
3	Floodplain Forest
4	Upland Forest
5	Upland Forest
6	Upland Forest
7	Upland Forest
8	Upland Old Field
9	Lowland Old Field
10	Lowland Old Field
11	Creek Forest
12	Upland Old Field
13	Upland Forest
14	Upland Old Field
15	Upland Forest
16	Creek Forest
17	Upland Forest
18	Upland Forest
19	Lowland Old Field
20	Upland Old Field
21	Upland Forest
22	Upland Old Field
23	Creek Forest
24	Creek Forest
25	Lowland Old Field
26	Floodplain Forest
27	Floodplain Forest
28	Lowland Old Field
29	Upland Old Field
30	Floodplain Forest
31	Upland Forest
32	Upland Forest
33	Floodplain Forest
34	Lowland Old Field
35	Floodplain Forest
36	Creek Forest
37	Creek Forest
38	Floodplain Forest
39	Hedgerow
40	Hedgerow
41	Hedgerow
42	Hedgerow
43	Hedgerow
44	Hedgerow
45	Hedgerow
46	Hedgerow
47	Pond and Pond Bank
48	Pond and Pond Bank
49	Pond and Pond Bank
50	Pond and Pond Bank

APPENDIX B

Computations for Vegetational Analyses

Class 1 vegetational data were analyzed as follows:

(1) $$\text{Relative density} = \frac{\text{No. of individuals of each species}}{\text{No. of individuals of all species}} \times 100$$

(2) $$\text{Relative dominance} = \frac{\text{Total basal area of each species}}{\text{Total basal area of all species}} \times 100$$

(3) Importance value (200) = Relative density + Relative dominance

(4) Total basal area = Cover by trunk (trees)

Class 2 data were analyzed as follows:

(1) $$\text{Density} = \frac{\text{No. of individuals of each species}}{0.01 \text{ acre}}$$

The assessment of the Class 3 vegetation using the Braun-Blanquet method was accomplished by averaging the percent cover of each plant species in the habitat types. Cover values were:

(1) Very scant (covering less than 5 percent of the ground surface)

(2) Cover 5 percent to 25 percent of ground surface

(3) Cover 25 percent to 50 percent of ground surface

(4) Cover 50 percent to 75 percent of ground surface

(5) Cover 75 percent to 100 percent of ground surface

Density (trees/acre), total basal area, and importance value (200) of Class 1 vegetation (tree layer) by habitat type, Delta expansion area.

Species	Density (Trees/Acre)	Total Basal Area	IV (200)
Creek Forest			
Ash *Fraxinus* spp.	37.0	8.9	23.8
Dead trees	22.3	8.3	17.8
American elm *Ulmus americana* L.	23.5	5.7	15.1
Black cherry *Prunus serotina* Ehrh.	20.4	5.9	14.3
River birch *Betula nigra* L.	18.7	5.7	13.5
Sycamore *Platanus occidentalis* L.	9.8	5.5	10.1
Red maple *Acer rubrum* L.	16.1	2.8	9.1
Black oak *Quercus velutina* Lam.	6.7	5.6	9.1
Pin oak *Quercus palustris* Muench.	11.3	3.8	8.5
Sassafras *Sassafras albidum* (Nutt.)	13.9	1.4	6.6
Slippery elm *Ulmus rubra* Muhl.	12.7	1.7	6.5
Honey locust *Gleditsia triacanthos* L.	5.8	3.3	5.9
White oak *Quercus alba* L.	4.8	2.9	5.2
Persimmon *Diospyros virginiana* L.	9.6	1.3	5.0
Carya ovalis-*C. glabra*	5.8	1.9	4.3
Shagbark hickory *Carya ovata* (Mill.)	6.7	1.6	4.3

Appendix C . (Continued).

Species	Density (Trees/Acre)	Total Basal Area	IV (200)
Red oak *Quercus rubra* L.	4.3	2.2	4.2
Boxelder *Acer negundo* L.	5.0	1.5	3.6
Sugarberry *Celtis laevigata* Willd.	4.6	1.7	3.6
Winged elm *Ulmus alata* Michx.	6.7	0.9	3.5
Catalpa *Catalpa speciosa* Warder	2.6	2.1	3.5
Black walnut *Juglans nigra* L.	3.8	1.6	3.3
Sugar maple *Acer saccharum* Marsh.	4.8	1.1	3.1
Red mulberry *Morus rubra* L.	4.6	0.7	2.5
Flowering dogwood *Cornus florida* L.	4.8	0.4	2.2
Bitternut hickory *Carya cordiformis* (Wang.)	3.1	0.6	1.8
Musclewood *Carpinus caroliniana* Walt.	2.4	0.8	1.8
Mockernut hickory *Carya tomentosa* (Poir.)	1.0	0.9	1.4
Shingle oak *Quercus imbricaria* Michx.	2.4	0.4	1.3
Bur oak *Quercus macrocarpa* Michx.	0.7	0.5	0.9
Cherrybark oak *Quercus falcata* var. *pagodaefolia*	0.7	0.4	0.7
Hackberry *Celtis occidentalis* L.	1.2	0.2	0.6

Appendix C. (Continued).

Species	Density (Trees/Acre)	Total Basal Area	IV (200)
Black gum *Nyssa sylvatica* Marsh.	0.5	0.3	0.5
Eastern red cedar *Juniperus virginiana* L.	0.7	0.2	0.5
Hawthorn *Crataegus* sp.	1.0	0.1	0.4
Blackjack oak *Quercus marilandica* Muench.	0.2	0.2	0.4
Redbud *Cercis canadensis* L.	0.7	T*	0.3
Osage-orange *Maclura pomifera* (Raf.)	0.2	0.2	0.3
Unknown	0.5	0.1	0.2
Southern red oak *Quercus falcata* Michx.	0.5	T	0.2
Grape *Vitis* spp.	0.5	T	0.2
Sweetgum *Liquidambar styraciflua* L.	0.2	T	0.1
TOTAL	282.8	83.4	200.2
Floodplain Forest			
Red maple	134.6	20.6	56.7
Sweetgum	43.0	13.0	25.2
Pin oak	17.3	16.6	22.8
Ash	44.6	10.0	22.3
River birch	37.4	6.7	16.9
American elm	30.0	7.3	15.7
Dead trees	20.6	3.1	8.6
Slippery elm	10.3	1.7	4.5

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*T = trace or less than 0.1.

Appendix C. (Continued).

Species	Density (Trees/Acre)	Total Basal Area	IV (200)
Black cherry	9.4	1.6	4.2
Silver maple *Acer saccharinum* Marsh.	7.9	0.8	2.9
Cherrybark oak	3.6	1.6	2.7
Sassafras	6.5	0.5	2.1
Persimmon	5.3	0.5	1.9
Sugarberry	3.6	0.9	1.9
Sycamore	4.1	0.6	1.7
Shagbark hickory	3.6	0.6	1.6
Red mulberry	3.8	0.5	1.5
Boxelder	1.0	0.8	1.2
Honey locust	2.2	0.5	1.1
Red oak	2.2	0.4	0.9
Bitternut hickory	1.7	0.2	0.6
Black oak	1.2	0.2	0.5
Black gum	0.7	0.2	0.4
Black walnut	0.7	0.1	0.3
Black willow *Salix nigra* Marsh.	0.7	0.1	0.3
Winged elm	1.0	0.1	0.3
Flowering dogwood	0.5	0.1	0.2
Mockernut hickory	0.2	0.1	0.2
Carya ovalis-*C. glabra*	0.5	0.1	0.2
Unknown	0.5	T	0.2
Hophornbeam *Ostrya virginiana* (Mill.)	0.5	T	0.2

Appendix C. (Continued).

Species	Density (Trees/Acre)	Total Basal Area	IV (200)
Musclewood	0.2	T	0.1
Hawthorn	0.2	T	0.1
Southern red oak	0.2	T	0.1
Post oak	0.2	T	0.1
TOTAL	400.0	89.5	200.2
Lowland Old Field			
Dead trees	0.7	1.6	48.1
Cottonwood *Populus deltoides* Marsh.	5.0	0.5	45.7
Black willow	2.9	0.8	39.6
Sycamore	2.2	0.2	19.2
Red oak	0.7	0.1	6.5
River birch	0.7	0.1	6.4
Persimmon	0.5	0.1	6.1
Sassafras	0.5	0.1	6.0
Carya ovalis-*C. glabra*	0.5	0.1	5.9
Ash	0.5	0.1	5.7
Black cherry	0.5	T	3.8
Hawthorn	0.2	T	2.8
Shingle oak	0.2	T	2.3
Black oak	0.2	T	1.9
TOTAL	15.3	3.7	200.0
Ponds and Pond Banks			
River birch	51.2	6.9	72.4
Black willow	26.9	5.0	44.6

Appendix C. (Continued).

Species	Density (Trees/Acre)	Total Basal Area	IV (200)
Dead trees	7.1	1.9	14.5
Sycamore	5.0	1.7	12.0
Red maple	7.6	0.7	9.1
American elm	5.9	0.8	8.6
Boxelder	0.8	1.0	5.5
Ash	5.5	0.4	6.3
Musclewood	2.9	0.7	5.5
Bitternut hickory	0.4	1.0	5.2
Persimmon	2.5	0.2	3.1
Red mulberry	2.5	0.2	3.0
Honey locust	2.5	0.2	3.0
Silver maple	1.3	0.1	1.5
Winged elm	1.3	0.1	1.3
Grape	0.8	0.1	1.2
Eastern red cedar	0.4	0.1	0.7
Sassafras	0.4	0.1	0.7
Black walnut	0.4	T	0.5
Osage-orange	0.4	T	0.5
Hawthorn	0.4	T	0.4
Black gum	0.4	T	0.4
TOTAL	126.6	21.2	200.0
Upland Forest			
Carya ovalis-*C. glabra*	54.9	14.1	46.2
Shagbark hickory	36.6	10.4	32.2
Post oak	23.2	10.0	25.3

Appendix C. (Continued).

Species	Density (Trees/Acre)	Total Basal Area	IV (200)
White oak	19.0	11.1	24.9
Black oak	16.2	10.0	22.0
Shingle oak	9.9	1.9	7.4
Ash	10.1	1.5	7.0
Dead trees	9.6	1.5	6.7
Red oak	5.4	2.5	6.2
Black cherry	4.4	0.8	3.1
Blackjack oak	2.4	1.1	2.7
Red maple	1.2	1.0	2.0
Black hickory _Carya_ _texana_ Buckl.	2.6	0.5	1.9
Flowering dogwood	3.0	0.3	1.8
Sassafras	2.6	0.4	1.8
Pin oak	0.6	0.7	1.3
Persimmon	2.1	0.2	1.3
Winged elm	1.8	0.2	1.1
Slippery elm	1.2	0.3	1.0
Black gum	0.9	0.2	0.7
Southern red oak	0.5	0.3	0.7
Bitternut hickory	0.5	0.3	0.6
Black walnut	0.2	0.3	0.5
Unknown	0.5	T	0.3
Sweetgum	0.3	0.1	0.2
American elm	0.3	T	0.2
Honey locust	0.2	0.1	0.2
Sugarberry	0.3	T	0.2

Appendix C. (Continued).

Species	Density (Trees/Acre)	Total Basal Area	IV (200)
Red mulberry	0.2	0.1	0.2
River birch	0.3	T	0.2
Hawthorn	0.2	T	0.1
Mockernut hickory	0.2	T	0.1
TOTAL	211.4	69.9	200.1
Upland Old Field			
Sassafras	6.2	0.6	37.1
Pin oak	0.6	1.3	32.9
Black oak	5.9	0.5	32.6
Ash	3.9	0.3	20.8
Flowering dogwood	3.6	0.3	18.7
Persimmon	3.1	0.3	17.9
Black cherry	1.7	0.3	12.1
Red maple	0.8	0.2	8.8
Dead trees	0.8	0.1	5.5
Blackjack oak	0.3	0.1	2.8
Winged elm	0.6	T	2.5
Red oak	0.3	0.1	2.4
American elm	0.3	T	1.8
Slippery elm	0.3	T	1.5
Southern red oak	0.3	T	1.4
Post oak	0.3	T	1.2
TOTAL	29.0	4.1	200.0
Hedgerow			
Osage-orange	44.7	10.7	59.0

Appendix C. (Concluded).

Species	Density (Trees/Acre)	Total Basal Area	IV (200)
Sassafras	33.8	5.0	36.1
Black cherry	17.0	5.7	26.9
American elm	12.4	3.2	16.9
Pin oak	8.2	2.9	13.4
Honey locust	5.9	3.3	12.9
Red maple	9.5	2.3	12.5
Dead trees	6.3	1.2	7.5
Sugarberry	1.5	0.5	2.4
Red mulberry	1.1	0.5	2.0
Persimmon	1.9	0.2	1.8
Ash	0.4	0.3	1.2
Sweetgum	1.3	0.1	1.1
Winged elm	1.1	0.1	1.0
Shingle oak	0.6	0.2	1.0
Black willow	0.4	0.3	1.0
River birch	1.1	0.1	1.0
Sycamore	0.2	0.3	0.9
White oak	0.4	0.1	0.5
Cottonwood	0.2	T	0.2
Black oak	0.2	T	0.2
Black walnut	0.2	T	0.2
Eastern red cedar	0.2	T	0.2
Boxelder	0.2	T	0.2
TOTAL	148.8	37.0	200.1

APPENDIX D

Density (trees/acre) of Class 2 Vegetation, Delta Expansion Area

	CREEKS & STREAMS	CREEK FOREST	FLOODPLAIN FOREST	LOWLAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGEROWS	ANTHROPOGENIC LANDS
Silver maple *Acer saccharinum* L.			7.1						
Red maple *Acer rubrum* L.		21.4	245.2		45.8	1.5		2.1	
Sugar maple *Acer saccharum* Marsh.		2.4							
Boxelder *Acer negundo* L.		9.5							
Grape *Vitis* spp.		7.1	7.1			1.5			
Serviceberry *Amelanchier arborea* (Michx.f)			19.0						
Hawthorn *Crataegus* sp.					16.7				
Black cherry *Prunus serotina* Ehrh.		21.4	11.9	4.8		9.1	2.8	20.8	
Redbud *Cercis canadensis* L.						1.5			
Honey locust *Gleditsia triacanthos* L.								14.6	
Black locust *Robinia pseudoacacia* L.						3.0			
Sweetgum *Liquidambar styraciflua* L.			4.8						
Sycamore *Platanus occidentalis* L.			4.8	9.5	4.2				
Shingle oak *Quercus imbricaria* Michx.						19.7	2.8		
Blackjack oak *Quercus marilandica* Muench.						1.5			

	CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
Southern red oak *Quercus falcata* Michx.						3.0		2.1	
Red oak *Quercus rubra* L.						4.5			
Pin oak *Quercus palustris* Muench.			9.5			1.5		8.3	
Black oak *Quercus velutina* Lam.		2.4	2.4	7.1		10.6	8.3		
White oak *Quercus alba* L.			4.8			6.1			
Post oak *Quercus stellata* Wang.						9.1			
River birch *Betula nigra* L.		21.4	4.8		45.8				
Musclewood *Carpinus caroliniana* Walt.		7.1							
Bitternut hickory *Carya cordiformis* (Wang.)		16.7							
Mockernut hickory *Carya tomentosa* (Poir.)							2.8		
Shagbark hickory *Carya ovata* (Mill.)		4.8				16.7	5.5		
Carya ovalis-*C. glabra*		2.4	2.4			24.2			
Black willow *Salix nigra* Marsh.				31.0	37.5				
American elm *Ulmus americana* L.		31.0	21.4		58.3	4.5		33.3	
Winged elm *Ulmus alata* Michx.		14.2	7.1			6.1	2.8		

	CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
Slippery elm *Ulmus rubra* Muhl.		28.6	19.0			3.0			
Sugarberry *Celtis laevigata* Willd.		4.8	7.1		4.2			2.1	
Red mulberry *Morus rubra* L.		4.8	4.8		20.8	3.0		2.1	
Sassafras *Sassafras albidum* (Nutt.)		57.1				19.7	13.9	106.3	
Flowering dogwood *Cornus florida* L.		11.9				9.1		2.1	
Black gum *Nyssa sylvatica* Marsh		7.1	7.1	2.4		1.5			
Persimmon *Diospyros virginiana* L.		2.4	9.5		8.3	6.1	2.8		
Ash *Fraxinus* spp.		60.0	16.7		4.2	12.1		2.1	
Catalpa *Catalpa speciosa* Warder		2.4							
Dead trees		9.5	26.1		8.3	4.5		6.3	
Total Density (Trees/Acre)		350	443	55	254	183	42	202	

APPENDIX E

Cover Values of Class 3 Vegetation, Delta Expansion Area

	CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
Family: Ophioglossaceae (Adder's Tongues)									
Botrychium virginianum (L.)		1*	X**			X			
Ophioglossum vulgatum L.		X							
Family: Polypodiaceae (Ferns)									
Onoclea sensibilis L.		1	X	1					
Polystichum acrostichoides (Michx.)		X							
Dryopteris marginalis (L.)			X						X
Asplenium platyneuron (L.)		1				1			
Adiantum pedatum L.			X		X		X		
Family: Cupressaceae (Junipers and Cedars)									
Juniperus virginiana L.		X			X		X	X	
Family: Ranunculaceae (Buttercups)									
Delphinium tricorne Michx.						X	X		X
Ranunculus abortivus L.		X							
Ranunculus recurvatus Poir.		X							
Ranunculus septentrionalis Poir.			X						
Ranunculus hispidus Michx.						X			
Thalictrum hypoglaucum Rydb.		1							
Anemonella thalictroides (L.)		X							
Family: Nymphaeaceae (Waterlilies)									
Nuphar advena Ait.				1	2				

*1 = plant cover less than 5% of ground surface; 2 = 5-20% cover; 3 = 25-50% cover; 4 = 50-75% cover; and 5 = 75-100% cover.

**X = species was observed on the study area, but was not represented in the sampling data.

	CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
Family: Podophyllaceae (Mayapples)									
Podophyllum peltatum L.		X			X	1	1	X	
Family: Menispermaceae (Moonseeds)									
Menispermum canadense L.		X	1			X			
Family: Violaceae (Violets)									
Viola falcata Greene		1				1			
Viola papilionaceae Pursh		1	1	X	X	1			
Viola sororia Willd.		1							
Viola sagittata Ait.						X			
Viola eriocarpa Schw.		X	X						
Viola striata Ait.		X							
Viola rafinesquii Greene								X	X
Family: Papaveraceae (Poppies)									
Sanguinaria canadensis L.		X				X			
Family: Fumariaceae (Fumitory)									
Dicentra cucullaria (L.)		X							
Corydalis flavula (Raf.)						X			
Family: Cruciferae (Mustards)									
Brassica campestris L.				X				X	X
Sisymbrium officinale (L.)								X	
Barbarea vulgaris R.Br.				X			X	1	
Draba verna L.									X
Dentaria laciniata Muhl.		X	X			X			

	CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
Cardamine bulbosa (Schreb.)			X						
Cardamine hirsuta L.								X	X
Arabis virginica (L.)									X
Arabidopsis thaliana (L.)							1		X
Lepidium virginicum L.									X
Capsella bursa-pastoris (L.)									X
Family: Hypericaceae (St. John's-wort)									
Hypericum perforatum L.							X		X
Hypericum punctatum Lam.				X	1			1	
Hypericum mutilum L.						X			
Hypericum prolificum L.			1						
Family: Caryophyllaceae (Pinks)									
Cerastium brachypodum (Englem.)									X
Cerastium vulgatum L.								1	
Stellaria longifolia Muhl.			X	X					
Silene antirrhina L.							X		X
Dianthus armeria L.							X	1	
Family: Portulacaceae (Purslane)									
Claytonia virginica L.		X	X			X			
Family: Chenopodiaceae (Goosefoot)									
Chenopodium album L.							X		X
Family: Phytolaccaceae (Pokeweed)									
Phytolacca americana L.		1							

	CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
Family: Amaranthaceae (Amaranths)									
Froelichia gracilis (Hook.)							X		
Family: Polygonaceae (Buckwheat)									
Rumex acetosella L.				X	X		1	X	
Rumex altissimus Wood								X	
Rumex verticillatus L.				X					
Rumex patienta L.							X		
Rumex crispus L.				1			X		X
Polygonum ramosissimum Michx.							X		X
Polygonum persicaria L.							X		X
Polygonum hydropiperoides Michx.					X				
Polygonum virginianum L.		1							
Polygonum cuspidatum Sieb. & Zucc.							X		
Polygonum spp.					2			1	
Family: Simarubaceae (Quassia)									
Ailanthus altissima (Mill.)								1	X
Family: Geraniaceae (Geraniums)									
Geranium maculatum L.						X	1	1	
Geranium carolinianum L.				X				1	X
Family: Oxalidaceae (Wood-sorrel)									
Oxalis violacea L.							X		
Oxalis dillenii Jacq.				X		1	1	1	
Oxalis stricta L.		X	X	X		1	1	1	

	CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
Family: Balsaminaceae (Jewel-weed)									
Impatiens biflora Walt.		1	2	1	1	X	1	1	
Family: Polygalaceae (Milkwort)									
Polygala sanguinea L.				X			1		
Family: Euphorbiaceae (Spurge)									
Euphorbia carollata L.							1	1	
Euphorbia sp.					1	1	1		
Family: Staphyleaceae (Bladdernut)									
Staphylea trifolia L.		X							
Family: Aquifoliaceae (Holly)									
Ilex decidua Walt.			X			1	1		
Family: Anacardiaceae (Sumac)									
Rhus copallina L.				1	X	1	2	X	
Rhus glabra L.						X			
Rhus radicans L.		2	2	1	1	2	1	2	X
Family: Aceraceae (Maples)									
Acer saccharinum L.		X	X		X				X
Acer rubrum L.		X	1	1	1	X	X	X	X
Acer saccharum Marsh.		1	X						
Acer negundo L.		X	X	1	X			X	
Family: Rhamnaceae (Buckthorn)									
Ceanothus americanus L.							1		

	CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
Family: Vitaceae (Grapes)									
Vitis aestivalis Michx.		1	X		1	1	1	X	
Vitis cinerea Engelm.				1				1	
Vitis vulpina L.		1	1	1		X		1	
Parthenocissus quinquefolia (L.)		1	1	1	X	2	1	1	
Family: Rosaceae (Roses)									
Gillenia stipulata (Muhl.)				X		1			
Fragaria virginiana Duch.								X	
Potentilla recta L.				X					
Potentilla simplex Michx.		1		X	X	1	X		
Geum vernum (Raf.)		X							
Geum canadense Jacq.		1	1	1	1	1		1	
Agrimonia parviflora Ait.				1	1	1			
Rubus occidentalis L.							X		
Rubus allegheniensis Porter		1	1	1		1	1	1	
Rubus flagellaris Willd.					X	1	1	1	
Rosa multiflora Thunb.				X	X			1	
Rosa setigera Michx.		1		1	1		1	1	X
Rosa carolina L.						1	1	X	
Rosa spp.		1				1		1	
Amelanchier arborea (Michx. f)						X			
Crataegus sp.		X	X	X	X	1			
Prunus persica (L.)								X	

	CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
Prunus mahaleb L.									X
Prunus americana Marsh.								X	X
Prunus serotina Ehrh.		1	X	1		1	X	1	X
Family: Leguminosae (Peas)									
Cercis canadensis L.		1				1			X
Gleditsia triacanthos L.		X	X	X	X	X		1	X
Cassia fasciculata Michx.			1	1		1	1	1	
Baptisia leucantha T. & G.				X					
Trifolium repens L.				X	X		1	1	X
Trifolium pratense L.				X	1		1		X
Melilotus officinalis (L.)					X		X		X
Melilotus alba Desr.							X		X
Medicago lupulina L.				X			X	1	X
Psoralea psoralioides (Walt.)						X			X
Amorpha fruticosa L.				X					X
Tephrosia virginiana (L.)						X	X		
Robinia pseudoacacia L.						X		X	
Desmodium nudiflorum (L.)						X			
Desmodium ciliare (Muhl.)						X			
Desmodium spp.			1	1		1	1	X	
Lespedeza procumbens Michx.		1				1	1		
Lespedeza violacea (L.)				1		X	1		
Lespedeza striata (Thunb.)				X					X

	CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
Lespedeza stipulacea Maxim.			X			X	1		X
Stylosanthes biflora (L.)					X	1	1		X
Vicia villosa Roth									X
Lathyrus latifolius L.								X	X
Glycine max (L.)									X
Amphicarpa bracteata (L.)		1							
Family: Hydrangeaceae (Hydrangea)									
Hydrangea arborescens L.			X			X			
Family: Grossulariaceae (Gooseberry)									
Ribes missouriense Nutt.		1				1			
Family: Hamamelidaceae (Witch-hazel)									
Liquidambar styraciflua L.		X	1			X		X	
Family: Platanaceae (Plane-trees)									
Platanus occidentalis L.		X	X	X	X			X	
Family: Saxifragaceae (Alumroot)									
Heuchera hirsuticaulis (Wheelock)						X	X		
Family: Fagaceae (Beech)									
Quercus imbricaria Michx.		1		1		1		1	
Quercus marilandica Muench.		X				1	X		
Quercus falcata Michx.		X	X			X	X		
Quercus falcata var. *pagodaefolia*		X	X						
Quercus rubra L.		X	X	X		X	X		
Quercus palustris Muench.		X	1			X	X	X	

	CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
Quercus velutina Lam..		1	1	X		1	1	X	
Quercus alba L.		X				1		X	
Quercus macrocarpa Michx.		X							
Quercus stellata Wang.			X			1	X		
Quercus spp.		1				1			
Family: Betulaceae (Birch)									
Betula nigra L.		X	X	X	1	X			
Corylus americana Walt.		1	1	X		1		X	X
Carpinus caroliniana Walt.		X	X		X				
Ostrya virginiana (Mill.)						X			
Family: Juglandaceae (Walnut)									
Juglans nigra L.		X	X		X	X		X	X
Carya cordiformis (Wang.)		1	1	1	X	X			
Carya tomentosa (Poir.)		X	X			X			
Carya ovata (Mill.)		1	1			1	X		
Carya texana Buckl.				X					
Carya ovalis (Wang.)		X	X	X		X	X		
Carya glabra (Mill.)		X	X	X		X	X		
Carya spp.		1				1	1		
Family: Salicaceae (Willow)									
Populus alba L.							X		X
Populus deltoides Marsh.			X	X				X	
Salix nigra Marsh.			X	1	1			X	

	CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
Family: Ulmaceae (Elms)									
Ulmus americana L.		X	1		X	1	X	1	
Ulmus alata Michx.		X	1		X	1	1	X	
Ulmus rubra Muhl.		1	1	1	1	1	X		
Celtis occidentalis L.		X							
Celtis laevigata Willd.		X	X			X		X	
Family: Moraceae (Mulberry)									
Morus rubra L.		1	X		X	X		X	
Maclura pomifera (Raf.)		X			X			X	
Family: Urticaceae (Nettle)									
Boehmeria cylindrica (L.)		1	1	1	1				
Pilea pumila (L.)		1		X	1			1	
Laportea canadensis (L.)		1							
Family: Lauraceae (Laurel)									
Sassafras albidum (Nutt.)		1	1	X	X	2	1	1	X
Lindera benzoin (L.)		1	1			1			
Family: Passifloraceae (Passion-flower)									
Passiflora lutea L.						X	1		
Family: Onagraceae (Evening-primrose)									
Ludwigia palustris (L.)				1	2				
Oenothera biennis L.				1	X		1	1	X
Oenothera laciniata Hill							X		
Oenothera pilosella Raf.				X					

	CREEKS & STREAMS	CREEK FOREST	FLOODPLAIN FOREST	LOWLAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGEROWS	ANTHROPOGENIC LANDS
Circaea latifolia Hill			1						
Family: Callitrichaceae (Water-starworts)									
Callitriche heterophylla Pursh					2				
Family: Aristolochiaceae (Birthwort)									
Asarum reflexum Bickn.			X						
Family: Cornaceae (Dogwood)									
Cornus obliqua Raf.								X	
Cornus florida L.		1	X			1	X		
Nyssa sylvatica Marsh.		1	X		X	1			
Family: Umbelliferae (Carrots)									
Daucus carota L.				1			1	1	
Torilis japonica (Houtt.)							X		X
Sanicula gregaria Bickn.		X							
Sanicula canadensis L.		1						1	
Erigenia bulbosa (Michx.)		X							
Cicuta maculata L.			1	1					
Thaspium trifoliatum (L.)		X		X					
Pastinaca sativa L.							X		
Family: Ericaceae (Heath)									
Monotropa lanuginosa Michx.						X			
Family: Ebenaceae (Ebony)									
Diospyros virginiana L.		1	1	1	X	1	1	1	

	CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
Family: Primulaceae (Primrose)									
Lysimachia ciliata L.		X							
Family: Oleaceae (Olive)									
Fraxinus pennsylvanica Marsh.			X						
Fraxinus americana L.		1				1	X		
Fraxinus lanceolata Borkh.		1	1	X	X	1		X	
Family: Apocynaceae (Dogbane)									
Amsonia tabernaemontana Walt.									X
Apocynum cannabinum L.				X		1	X	1	X
Family: Asclepiadaceae (Milkweeds)									
Asclepias tuberosa L.							1		X
Asclepias amplexicaulis Sm.						X			
Asclepias syriaca L.				1		X	X	X	X
Asclepias variegata L.							X		X
Ampelamus albidus (Nutt.)								X	
Family: Polemoniaceae (Phlox)									
Phlox divaricata L.		X	X				X		
Polemonium reptans L.		X	X						
Family: Convolvulaceae (Morning-glory)									
Convolvulus americanus (Sims)				X				1	
Convolvulus arvensis L.							X		
Ipomoea pandurata (L.)							1		
Ipomoea hederacea Jacq.								X	

	CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
Ipomoea spp.				1		1	2		
Family: Solanaceae (Nightshade)									
Physalis sp.					X				
Solanum carolinense L.				1			1	1	
Datura stramonium L.								X	X
Family: Scrophulariaceae (Figworts)									
Verbascum thapsus L.							X		X
Verbascum blattaria L.							X		
Penstemon pallidus Small				X	X	X	1		
Penstemon calycosus Small				X					
Gratiola neglecta Torr.									X
Gratiola virginiana L.					X				
Veronica arvensis L.				X					
Family: Bignoniaceae (Trumpet-creeper)									
Catalpa speciosa Warder		1					X		X
Campsis radicans (L.)		1	1	2	1	1	1	2	X
Family: Acanthaceae (Acanthus)									
Ruellia humilis Nutt.							X	1	X
Family: Plantaginaceae (Plantains)									
Plantago rugelii Dec.							X	1	X
Plantago virginica L.				1			1		X
Plantago lanceolata L.					X		1	1	X
Plantago aristata Michx.				X	X		1		

	CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
Family: Boraginaceae (Borage)									
Mertensia virginica (L.)		X							
Family: Verbenaceae (Verbenas)									
Verbena urticifolia L.				X	X				
Verbena stricta Vent.					X				
Phyla lanceolata (Michx.)					1				
Family: Phrymaceae (Lopseed)									
Phryma leptostachya L.		1				X		X	
Family: Labiatae (Mints)									
Teucrium canadense L.				X					
Scutellaria leonardi Epling		X							
Glecoma hederacea L.		X							
Prunella vulgaris L.		X		X		X	1		
Stachys aspera Michx.				1					
Stachys tenuifolia Willd.			X						
Blephilia hirsuta (Pursh)				X					
Monarda bradburiana Beck						1	X		
Hedeoma pulegioides (L.)						X			
Pycnanthemum flexuosum (Walt.)			1	1	1	1	1	1	
Cunila origanoides (L.)						X			
Lycopus americanus Muhl.					X				
Family: Rubiaceae (Madders)									
Houstonia lanceolata (Poir.)				X					

	CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
Houstonia longifolia Gaertn.		1				1			
Houstonia pusilla Schoepf						X			
Houstonia minima Beck				X				X	
Cephalanthus occidentalis L.			1		2				
Diodia teres Walt.									X
Galium aparine L.				X			X	X	
Galium triflorum Michx.		X							
Galium pilosum Ait.		1	1			1			
Galium circaezans Michx.		1	1			1			
Galium concinnum T. & G.		1	1	X		1			
Galium obtusum Bigel.				1					
Family: Caprifoliaceae (Honeysuckle)									
Sambucus canadensis L.		X		1				1	
Viburnum prunifolium L.		X							
Symphoricarpos orbiculatus Moench		1	1	X		1		2	
Lonicera japonica Thunb.		1	2	1	X	1		3	
Family: Campanulaceae (Bellflower)									
Specularia perfoliata (L.)				X			X		X
Family: Lobeliaceae (Lobelia)									
Lobelia spicata Lam.						X	X		
Family: Valerianaceae (Valerian)									
Valerianella radiata (L.)									X

	CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
Family: Compositae (Composites)									
Ambrosia artemisiifolia L.				1	X	X	X	1	
Ambrosia trifida L.		X	1				X		X
Ambrosia bidentata Michx.				X			1		X
Xanthium commune Britt.				X			X		
Vernonia missurica Raf.				X					
Eupatorium purpureum L.				X					
Eupatorium perfoliatum L.			1	1			1		
Eupatorium serotinum Michx.				1	1				
Solidago ulmifolia Muhl.						1			
Solidago altissima L.			1	2	1			1	X
Solidago spp.		1	1	1	X	1	1	1	X
Boltonia recognita (Fern. & Grisc.)			1	1					
Aster novae-angliae L.						1			
Aster ericoides L.				1					
Aster spp.				1					
Erigeron philadelphicus L.		X	X	X					
Erigeron strigosus Muhl.				1	X		1	1	
Erigeron annuus (L.)				1			X		
Erigeron canadensis L.							X	1	
Antennaria plantaginifolia (L.)					X	1	1		
Gnaphalium purpureum L.							X		

	CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
Polymnia canadensis L.			1						
Silphium perfoliatum L.				X					
Rudbeckia hirta L.		1				1	1	1	
Helianthus spp.						1	1		
Verbesina helianthoides Michx.		1		X					
Coreopsis grandiflora Hogg				X			X		X
Bidens spp.		1	1	2				1	
Helenium nudiflorum Nutt.							1		
Achillea millefolium L.				X			1	1	
Achillea lanulosa Nutt.					X				
Cacalia suaveolens L.		1							
Chrysanthemum leucanthemum L.				1		X	1	X	X
Senecio aureus L.			X	X					
Senecio glabellus Poir.				X					
Cirsium discolor (Muhl.)		1	1	1			1	1	
Cirsium altissimum (L.)				1			1		
Serinia oppositifolia (Raf.)				X	X				X
Krigia dandelion (L.)				X					X
Krigia biflora (Walt.)		1				X			
Cichorium intybus L.							X		X
Lactuca scariola L.				1			X	1	
Lactuca canadensis L.				1					
Lactuca floridana (L.)		1	X						

	CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
Lactuca biennis (Moench)		1							
Sonchus arvensis L.				X					
Hieracium gronovii L.						X			
Pyrrhopappus carolinianus (Walt.)							1		
Family: Alismaceae (Water-plantain)									
Sagittaria latifolia Willd.				1					
Family: Naiadaceae (Naiad)									
Naias flexilis (Willd.)					1				
Family: Potamogetonaceae (Pondweeds)									
Potamogeton pusillus L.	X								
Family: Liliaceae (Lilies)									
Allium canadense L.			1	X	X		1		
Allium sativum L.							X		X
Hemerocallis fulva L.									X
Erythronium americanum Ker		X							
Erythronium albidum Nutt.		X	X	X					X
Asparagus officinalis L.							X		
Smilacina racemosa (L.)						1			
Polygonatum biflorum (Walt.)						X			
Polygonatum commutatum (Schultes)		X							
Yucca filamentosa L.							X		X
Trillium recurvatum Beck		X	X						
Smilax glauca Walt.		1		X	X	1	1		

	CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
Smilax *bona-nox* L.		1		X		1	1		
Smilax *hispida* Muhl.		1							
Smilax *rotundifolia* L.		X		X					
Smilax *pulverulenta* Michx.		X							
Family: Juncaceae (Rushes)									
Juncus *effusus* L.			X	1	X				
Juncus *tenuis* Willd.			1	1			1	1	
Juncus *marginatus* Rost K.		X							
Juncus *biflorus* Ell.			X				X		
Juncus *brachycarpus* Engelm.				1			X		
Juncus *acuminatus* Michx.					1			X	
Juncus *nodatus* Coville					X				
Family: Commelinaceae (Spiderworts)									
Tradescantia *virginica* L.				X			X		
Commelina *communis* L.				X					
Family: Amaryllidaceae (Amaryllis)									
Narcissus *pseudo-narcissus* L.				X			X	X	X
Narcissus *poeticus* L.							X	X	X
Family: Iridaceae (Irises)									
Sisyrinchium *bermudiana* L.		X		X					
Family: Dioscoreaceae (Yams)									
Dioscorea *quaternata* (Walt.)		1	1			1			

	CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
Family: Orchidaceae (Orchids)									
Orchis spectabilis L.		X							
Corallorhiza wisteriana Conrad						X			
Family: Araceae (Arums)									
Arisaema triphyllum (L.)			1						
Arisaema dracontium (L.)		1	X						
Family: Typhaceae (Cat-tails)									
Typha latifolia L.				1	X				
Family: Cyperaceae (Sedges)									
Cyperus ovularis (Michx.)				X					
Bulbostylis capillaris (L.)		X							
Eleocharis obtusa (Willd.)			1		1				
Eleocharis tenuis (Willd.)				X					
Eleocharis spp.					1				
Scirpus atrovirens Willd.				1	X				
Carex cruscorvi Shuttlw.			X						
Carex retroflexa Muhl.		1	X	X	X	1	X		
Carex vulpinoidea Michx.		X	X	1	1			1	
Carex tribuloides Wahl.			1	1					
Carex normalis Mack.			X	1	1		X		
Carex festucacea Schk.				X				1	
Carex crinita Lam.				X					
Carex hirsutella Mack.						1			

	CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
Carex granularis Muhl.				X					
Carex flaccosperma Dewey				X		X			
Carex shortiana Dewey				X			X		
Carex blanda Dewey		1	X			X	1	1	
Carex lupulina Muhl.			X						
Carex frankii Kunth		X		X					
Carex squarrosa L.			1						
Carex grayii Carey			X						
Carex spp.		1	1			1		1	
Family: Gramineae (Grasses)									
Arundinaria gigantea (Walt.)		X							
Bromus inermis Leyss.						1	X	X	X
Bromus purgans L.						1			
Bromus commutatus Schrad.				1		X	X	1	X
Bromus tectorum L.				X					X
Festuca elatior L.				2			2	1	X
Glyceria striata (Lam.)		1	1	1		1			
Poa pratensis L.								1	X
Poa compressa L.					1		X	2	X
Poa sylvestris A. Gray		1	X		X				
Poa chapmaniana Scribn.				X					X
Diarrhena americana Beauv.		1							
Uniola latifolia Michx.		1	1			X			

	CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
Dactylis glomerata L.							X	1	X
Triticum aestivum L.				X					X
Elymus villosus Muhl.		X							
Elymus virginicus L.		1	1	1				1	
Elymus canadensis L.				X	X	X			
Hystrix patula Moench						X	X	1	X
Hordeum pusillum Nutt.							1		X
Lolium perenne L.				X					X
Danthonia spicata (L.)						1	1		
Agrostis alba L.							1		
Agrostis hyemalis (Walt.)				1			1		
Cinna arundinacea L.			X						
Phleum pratense L.							X		
Muhlenbergia sobolifera (Muhl.)							X		X
Phalaris arundinacea L.				X					X
Leersia oryzoides (L.)		X		1	2	1			
Panicum depauperatum Muhl.						X			
Panicum microcarpon Muhl.		1		1			1	1	
Panicum dichotomum L.			X			1	X		
Panicum latifolium L.		1		1				1	
Panicum boscii Poir.						1			
Panicum scribnerianum Nash				X					
Panicum polyanthes Schult.							1		

	CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
Panicum lindheimeri Nash							X		
Panicum xalapense HBK.		1	1	X		1	1	1	
Panicum tennesseense Ashe				1					
Setaria faberii Herm.				X			X		X
Setaria viridis (L.)				X					
Andropogon scoparius Michx.							X		
Andropogon elliottii Chapm.					X	X	X		
Andropogon virginicus L.				2	X	1	2	1	X
Sorghum halepense (L.)						X	X	1	
Sorghum vulgare Pers.									X
Sorghastrum nutans (L.)							X		
Zea mays L.									X
Unknown Graminid		1				1		1	
Unknown	1	1	1	1	1	1	1		

APPENDIX F

Animals of the Delta Expansion Area

The mammals, birds, amphibians, and reptiles in this appendix are those species known or expected to occur in the Delta expansion area located in Saline and Williamson counties, Illinois. Included are those species that have been observed in field work, reported in the literature and unpublished research, and reported by knowledgeable individuals. Those animal species undocumented but expected are included due to the proximity of their known range and to the knowledge that their habitat requirements are satisfied in the study area. Abundance of the animals as delineated in this list refers only to the study area; those species categorized as rare or endangered were taken from the list of rare and endangered vertebrates of Illinois prepared by the Illinois Nature Preserves Commission (1971).

Mammal families follow the system of classification of Hall and Kelson (1959). Habitat requirements were based on Hoffmeister and Mohr (1957).

Nomenclature for the bird list follows the American Ornithologists' Union (1957 and 1973). Habitat requirements and abundance were taken from Hausman (1946), Robbins et al. (1966), Kleen and Bush (1971), Missouri Botanical Gardens (1974), and Terpening et al. (1975).

Basic herpetological nomenclature follows Schmidt (1953); information on habitat requirements was taken from Smith (1961).

MAMMALS OF THE STUDY AREA

	CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
Family: Didelphidae (Opossums)									
*Opossum Didelphis marsupialis virginiana Kerr		■	■	■	■	■	■	■	■
Family: Talpidae (Moles)									
*Eastern mole Scalopus aquaticus machrinus (Rafinesque)				■		■	■	■	■
Family: Soricidae (Shrews)									
Southeastern shrew Sorex longirostris longirostris Bachman		▨		▨			▨	▨	
*Short-tailed shrew Blarina brevicauda carolinensis (Bachman)		■	■	▬	▬	■	▬	■	
*Least shrew Cryptotis parva harlani (Duvernoy)				■			■	■	
Family: Vespertilionidae (Plainnose Bats)									
Little brown bat Myotis lucifugus lucifugus (Le Conte)		■	■	■	■	■			■
Gray bat Myotis grisescens (Howell)		▨	▨			▨			
Keen's bat Myotis keenii septentrionalis (Trouessart)		▬	▬			▬			▬
Indiana bat Myotis sodalis Miller and Allen		▨	▨			▨			
Small-footed brown bat Myotis leibii (Audubon and Bachman)		▬	▬			▬			
Silver-haired bat Lasionycteris noctivagans (Le Conte)		▬	▬			▬			

■ Common and/or abundant. ▨ Rare or endangered.

▬ Uncommon, but known to occur or likely to occur.

*Presence verified during this inventory.

MAMMALS OF THE STUDY AREA

	CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
Eastern pipistrel *Pipistrellus subflavus subflavus* (Cuvier)		●	●			●			●
*Big brown bat *Eptesicus fuscus fuscus* (Beauvois)		●	●			●			●
Hoary bat *Lasiurus cinereus cinereus* (Beauvois)		○	○			○			○
Red bat *Lasiurus borealis borealis* (Muller)		●	●			●			●
Family: Procyonidae (Raccoons)									
*Raccoon *Procyon lotor lotor* (Linnaeus)		●	●	●	●	○	○	●	
Family: Mustelidae (Weasels)									
*Long-tailed weasel *Mustela frenata noveboracensis* (Emmons)				●			●	●	●
*Mink *Mustela vison mink* Peale and Beauvois	●	●	○		●				
*Striped skunk *Mephitis mephitis nigra* (Peale and and Beauvois)		●		●	●		●	●	
Family: Canidae (Dogs)									
Red fox *Vulpes vulpes fulva* (Desmarest)		○		●		○	●		
*Gray fox *Urocyon cinereoargenteus cinereoargenteus* (Schreber)		●	●			●			
Coyote *Canis latrans frustror* Woodhouse				●			●	●	
*Domestic dog *Canis familiaris* Linnaeus		●	○	●	●	●	●	●	●

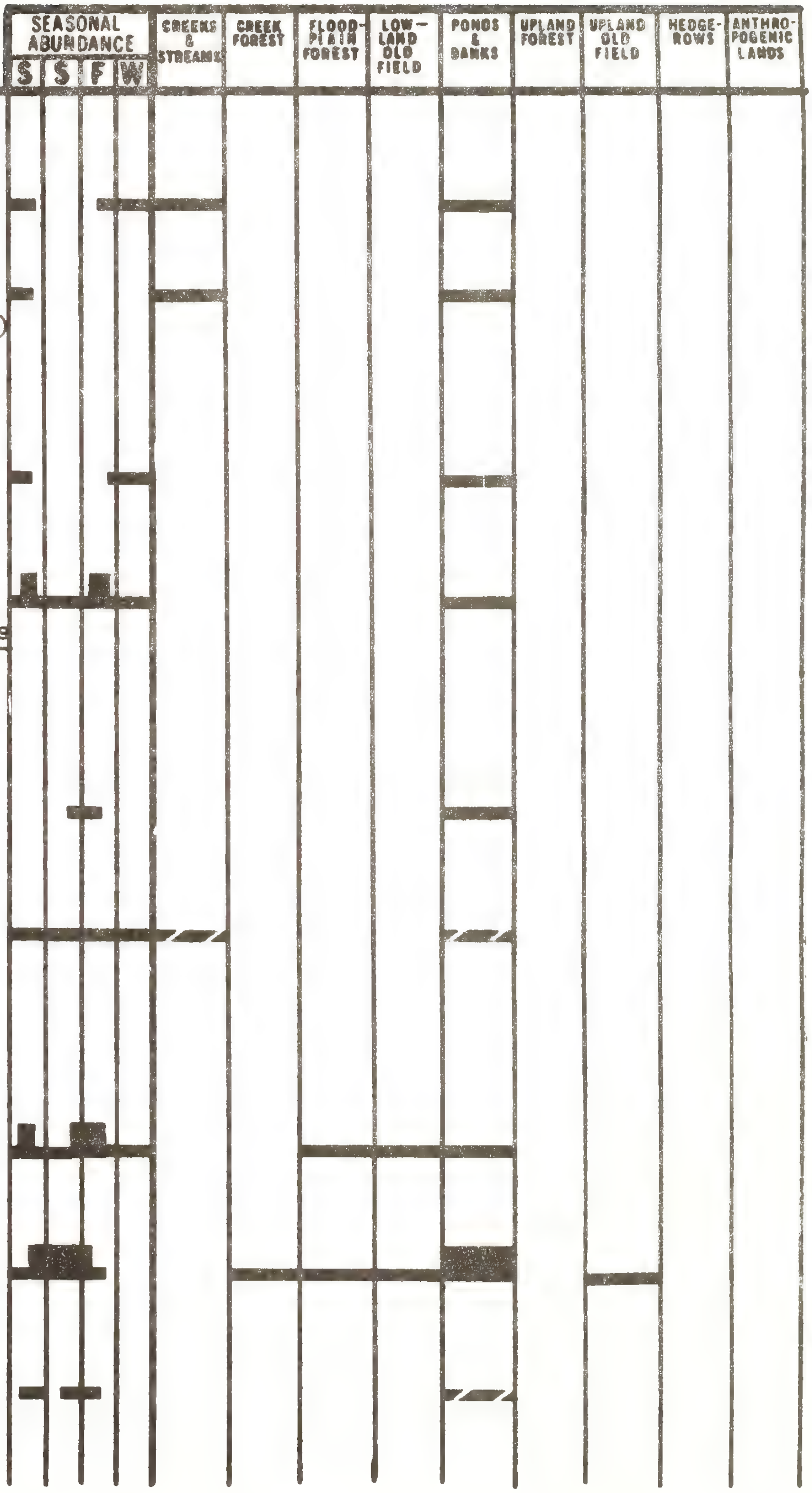
MAMMALS OF THE STUDY AREA

	CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
Family: Felidae (Cats)									
Bobcat *Lynx rufus rufus* (Schreber)		- -	- -			- -			
*Housecat *Felis catus* Linnaeus				—			—	▬	▬
Family: Sciuridae (Squirrels)									
*Woodchuck *Marmota monax monax* (Linnaeus)		—				—	▬	▬	—
*Eastern chipmunk *Tamias striatus griseus* Mearns		—				▬			
*Eastern gray squirrel *Sciurus carolinensis carolinensis* Gmelin		▬	▬			▬			
*Eastern fox squirrel *Sciurus niger rufiventer* Geoffroy		▬	▬			▬			
*Southern flying squirrel *Glaucomys volans volans* (Linnaeus)		▬	▬			▬			
Family: Castoridae (Beavers)									
*Beaver *Castor canadensis michiganensis* Bailey					—				
Family: Cricetidae (New World Mice)									
*Deer mouse *Peromyscus maniculatus bairdii* (Hoy and Kennicott)		—	—	▬		—	▬	▬	—
*White-footed mouse *Peromyscus leucopus leucopus* (Rafinesque)		▬	▬	—		▬	—	—	—
Rice rat *Oryzomys palustris palustris* (Harlan)				- -	- -				

MAMMALS OF THE STUDY AREA

	CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
*Southern bog lemming _Synaptomys cooperi gossii_ (Coues)				■	■		—	—	
*Prairie vole _Microtus ochrogaster ochrogaster_ (Wagner)				■	■		■	■	
*Pine vole _Pitymys pinetorum auricularis_ (Bailey)		■		—		■	■	■	
*Muskrat _Ondatra zibethicus zibethicus_ (Linnaeus)	—				■				
Family: Muridae (Old World Mice)									
*Norway rat _Rattus norvegicus norvegicus_ (Berkenhout)							—	—	■
*House mouse _Mus musculus domesticus_ Rutty				—			—	■	■
Family: Zapodidae (Jumping Mice)									
*Meadow jumping mouse _Zapus hudsonius intermedius_ Krutzsch		—		—	—				
Family: Leporidae (Rabbits and Hares)									
*Eastern cottontail _Sylvilagus floridanus mearnsii_ (Allen)		■	—	■			■	■	
Swamp rabbit _Sylvilagus aquaticus aquaticus_ (Bachman)		—		—					
Family: Cervidae (Deer)									
*White-tailed deer _Odocoileus virginianus borealis_ Miller		■	■	■		■	■	■	■

BIRDS OF THE STUDY AREA



Order: Gaviiformes (Loons)

Common loon
Gavia immer (Brunnich)

Red-throated loon
Gavia stellata (Pontoppidan)

Order: Podicipediformes (Grebes)

Horned grebe
Podiceps auritus cornutus Gmelin

Pied-billed grebe
Podilymbus podiceps podiceps (Linnaeus)

Order: Pelecaniformes (Pelicans and Allies)

White pelican
Pelecanus erythrorhynchos Gmelin

Double-crested cormorant
Phalacrocorax auritus auritus (Lesson)

Order: Ciconiiformes (Herons and Allies)

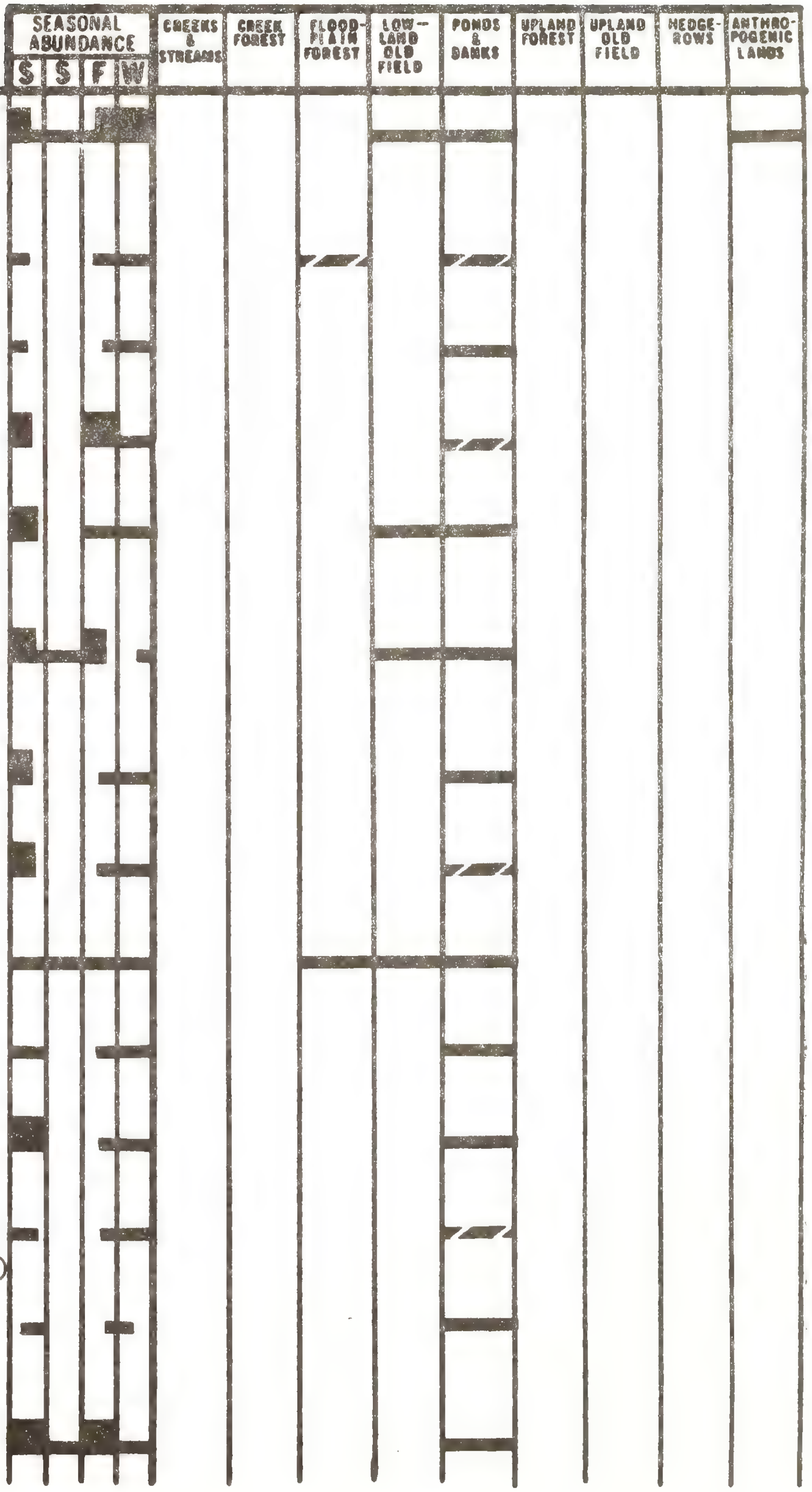
Great blue heron
Ardea herodias wardi Ridgway

*Green heron
Butorides virescens virescens (Linnaeus)

Little blue heron
Florida caerulea caerulea (Linnaeus)

BIRDS OF THE STUDY AREA

	SEASONAL ABUNDANCE				CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
	S	S	F	W									
Cattle egret *Bubulcus ibis ibis* Linnaeus	▬	▬											▬
Great egret *Casmerodius albus egretta* (Gmelin)	▬	█	▬		▬				▬				
Snowy egret *Egretta thula thula* (Molina)	▬	▬	▬		╍								
Black-crowned night heron *Nycticorax nycticorax hoactli* (Gmelin)	▬	▬	▬				╍						
Yellow-crowned night heron *Nyctanassa violacea violacea* (Linnaeus)	▬	▬	▬				▬	▬					
Least bittern *Ixobrychus exilis exilis* (Gmelin)	▬	▬							▬				
American bittern *Botaurus lentiginosus* (Rackett)	▬	▬	▬					╍	╍				
Order: Anseriformes (Ducks, Geese, and Swans)													
*Canada goose *Branta canadensis interior* Todd; *B. c. maxima* Delacour; *B. c. hutchinsii* (Richardson)	█	▬	█	█			▬		▬				▬
White-fronted goose *Anser albifrons frontalis* Baird			▬						▬				▬
Snow goose *Chen caerulescens caerulescens* (Linnaeus)	▬		▬	▬					▬				▬



*Mallard
Anas platyrhynchos platyrhynchos Linnaeus

*Black duck
Anas rubripes Brewster

Gadwall
Anas strepera Linnaeus

*Pintail
Anas acuta Linnaeus

Green-winged teal
Anas crecca carolinensis Gmelin

*Blue-winged teal
Anas discors discors Linnaeus

American wigeon
Mareca americana (Gmelin)

Northern shoveler
Anas clypeata (Linnaeus)

*Wood duck
Aix sponsa (Linnaeus)

Redhead
Aythya americana (Eyton)

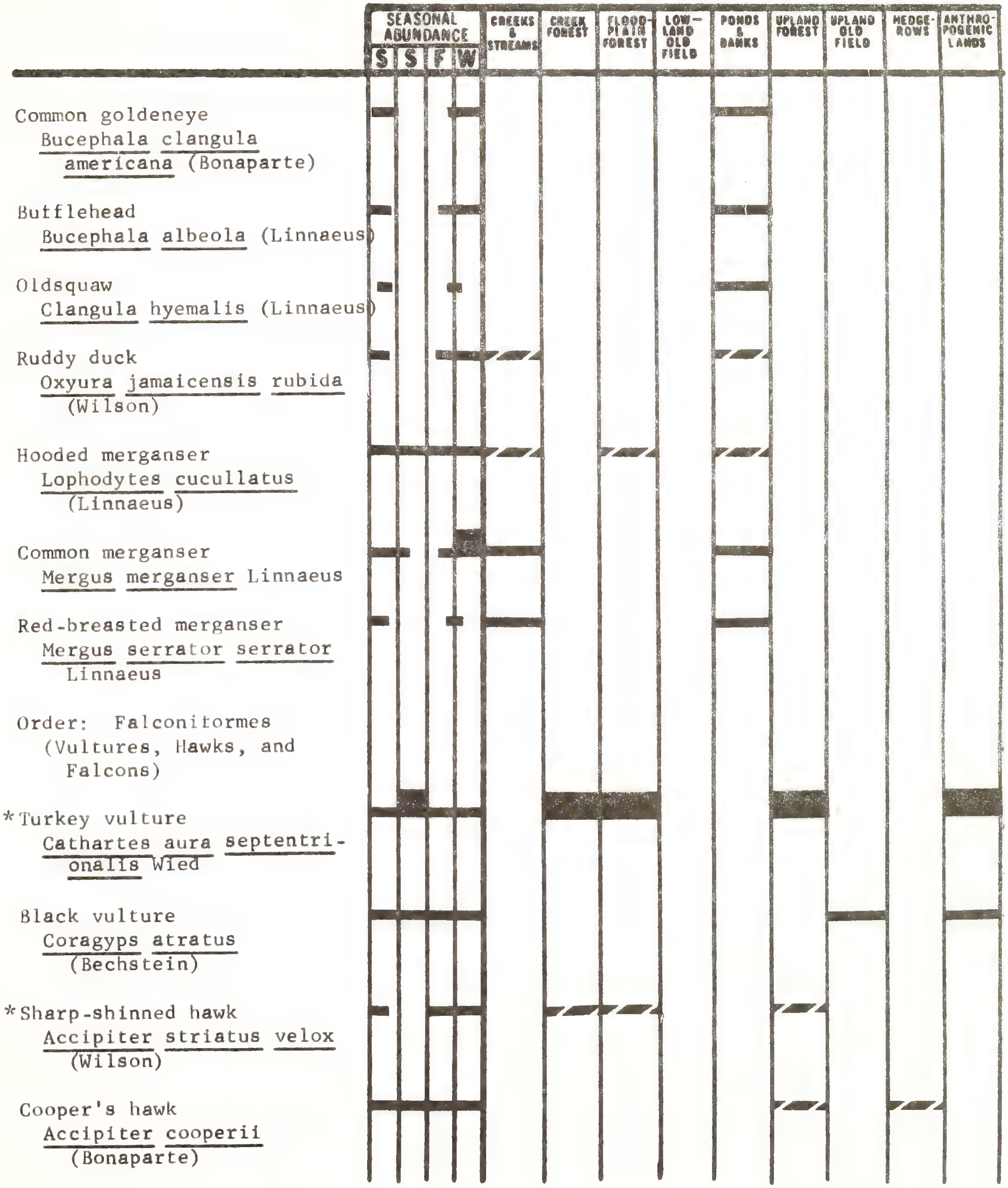
*Ring-necked duck
Aythya collaris (Donovan)

Canvasback
Aythya valisineria (Wilson)

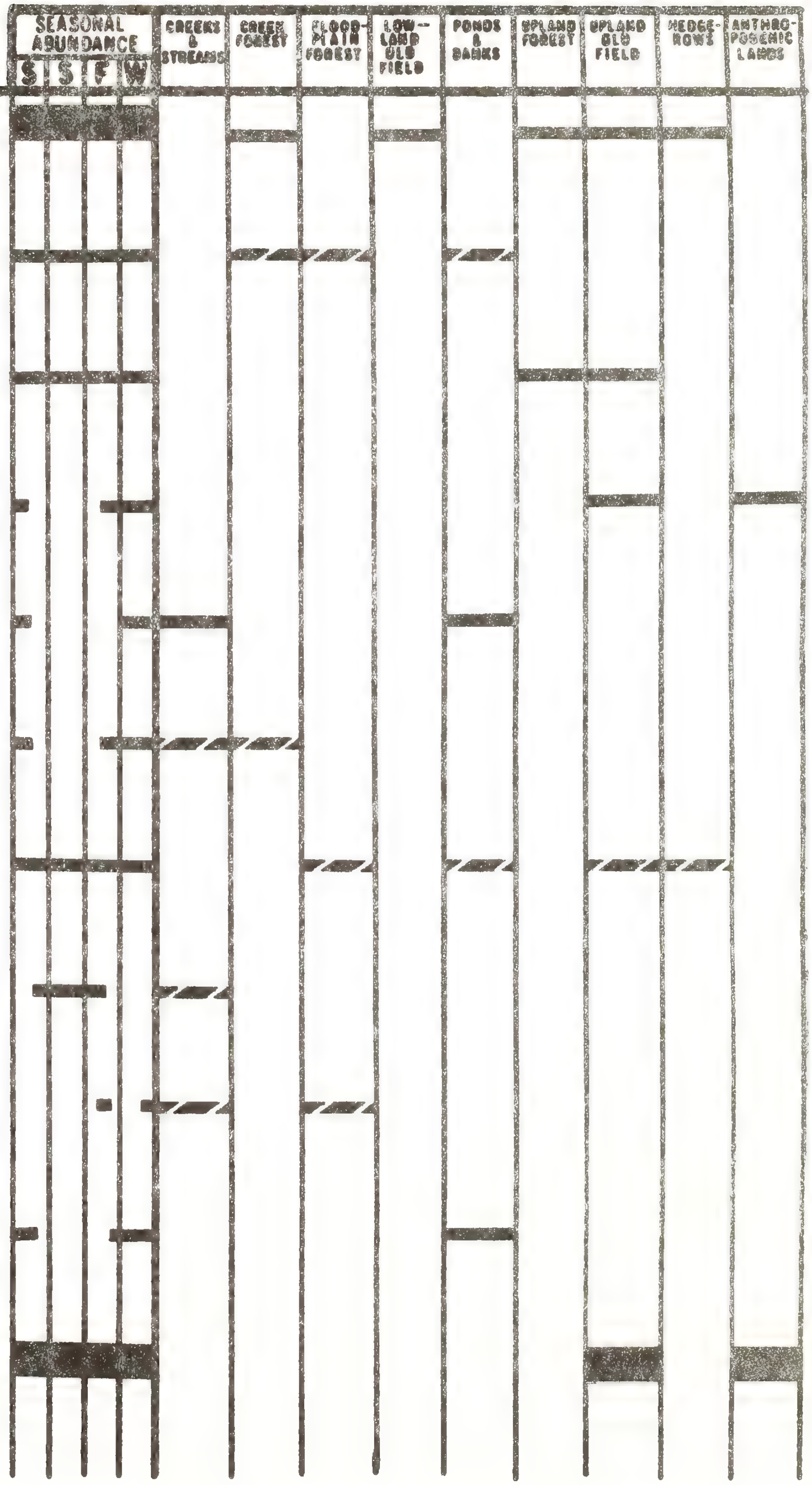
Greater scaup
Aythya marila nearctica Stejneger

*Lesser scaup
Aythya affinis (Eyton)

BIRDS OF THE STUDY AREA



BIRDS OF THE STUDY AREA



*Red-tailed hawk
Buteo jamaicensis borealis (Gmelin)

*Red-shouldered hawk
Buteo lineatus lineatus (Gmelin)

*Broad-winged hawk
Buteo platypterus platypterus (Vieillot)

Rough-legged hawk
Buteo lagopus sancti-johannis (Gmelin)

Golden eagle
Aquila chrysaetos canadensis (Linnaeus)

Bald eagle
Haliaeetus leucocephalus leucocephalus (Linnaeus)

*Marsh hawk
Circus cyaneus hudsonius (Linnaeus)

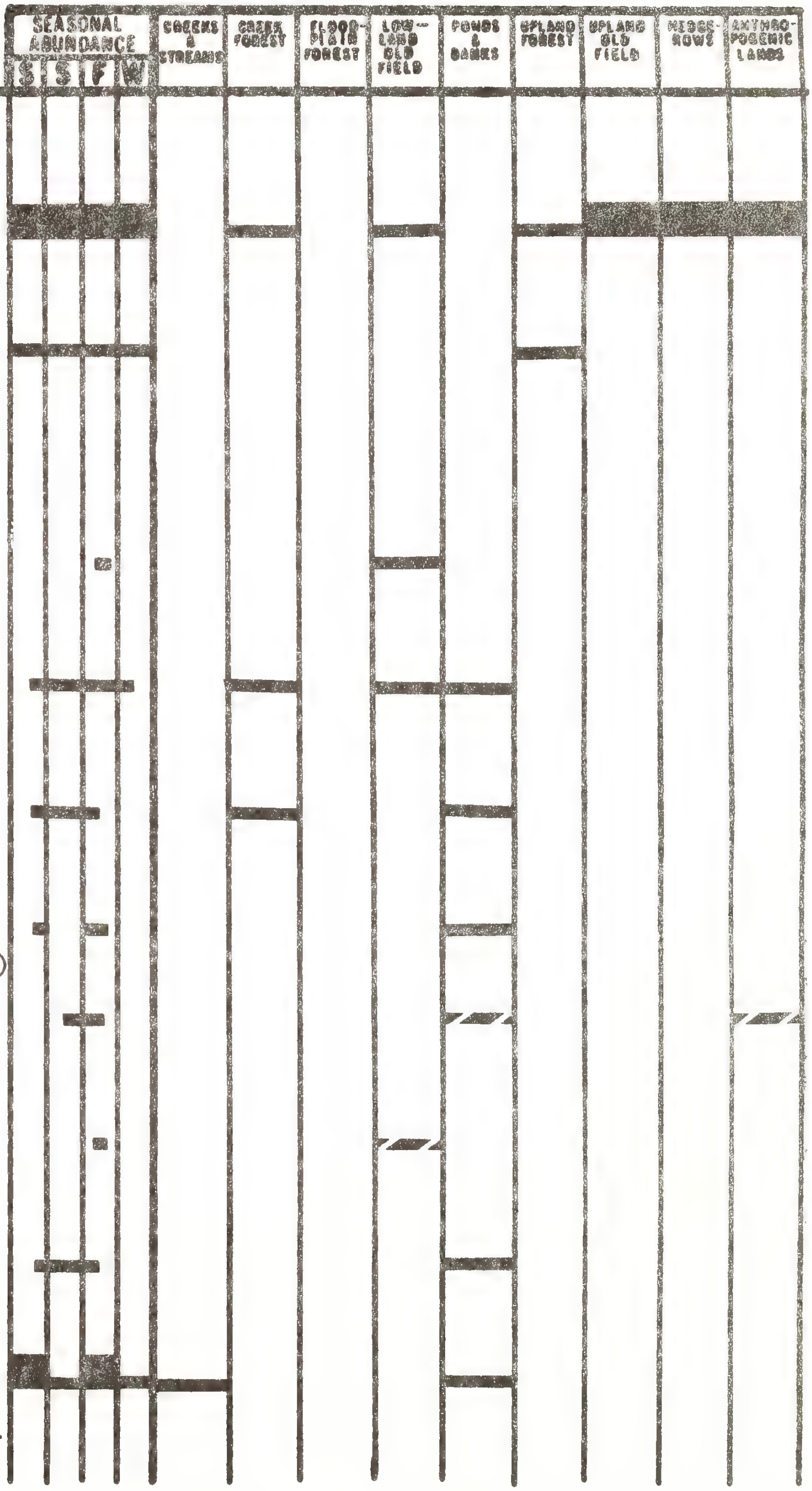
Osprey
Pandion haliaetus carolinensis (Gmelin)

Peregrine falcon
Falco peregrinus anatum Bonaparte

Merlin
Falco columbarius columbarius Linnaeus; _F. c. richardsonii_ Ridgway

*American kestrel
Falco sparverius sparverius Linnaeus

BIRDS OF THE STUDY AREA



Order: Galliformes
(Gallinaceous Birds)

*Bobwhite
Colinus virginianus
virginianus (Linnaeus)

Turkey
Meleagris gallopavo
silvestris Vieillot

Order: Gruiformes (Cranes
and Allies)

Sandhill crane
Grus canadensis tabida
(Peters)

*King rail
Rallus elegans elegans
Audubon

Virginia rail
Rallus limicola limicola
Vieillot

Sora
Porzana carolina (Linnaeus)

Yellow rail
Coturnicops noveboracensis
noveboracensis (Gmelin)

Black rail
Laterallus jamaicensis
jamaicensis Gmelin

Common gallinule
Gallinula chloropus
cachinnans Bangs

American coot
Fulica americana americana
Gmelin

BIRDS OF THE STUDY AREA

	SEASONAL ABUNDANCE				CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
	S	S	F	W									
Order: Charadriiformes (Shorebirds, Gulls, and Allies)													
Semipalmated plover *Charadrius semipalmatus* Bonaparte	▬		▬		▬								
Piping plover *Charadrius melodus circumcinctus* (Ridgway)			▬		▬				▬				
* Killdeer *Charadrius vociferus vociferus* Linnaeus	■	■	■	▬					▬			▬	■
American golden plover *Pluvialis dominica dominica* (Muller)	■		▬					▬			▬		▬
Black-bellied plover *Pluvialis squatarola* (Linnaeus)	▬		▬				▬	▬	▬				
* American woodcock *Philohela minor* (Gmelin)	▬	▬	▬	▬		▬	▬		▬	▬		▬	
Common snipe *Capella gallinago gallinago* (Linnaeus)	▬		▬	▬				▨	▨				
* Upland sandpiper *Bartramia longicauda* (Bechstein)	▬	▬									▨		▨
* Spotted sandpiper *Actitis macularia* (Linnaeus	▬	▬	▬		▬				▬				
* Solitary sandpiper *Tringa solitaria solitaria* Wilson	▬	▬	▬		▬				▬				
Willet *Catoptrophorus semipalmatus inornatus* (Brewster)	▬	▬			▬								

	SEASONAL ABUNDANCE				CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
	S	S	F	W									
Greater yellowlegs Tringa melanoleuca (Gmelin)	▬		▬					▬	▬				
Lesser yellowlegs Tringa flavipes (Gmelin)	▬		▬					▬	▬				
Pectoral sandpiper Calidris melanotos (Vieillot)	▬		▬					▬	▬				
White-rumped sandpiper Calidris fuscicollis (Vieillot)			▬		▬				▬				
Baird's sandpiper Calidris bairdii (Coues)	▬		▬						▬				
Least sandpiper Calidris minutilla (Vieillot)	▬		▬		▬				▬				
Dunlin Calidris alpina pacifica (Coues)	▬		▬		▬								
Semipalmated sandpiper Calidris pusilla (Linnaeus)	▬		▬		▬				▬				
Western sandpiper Calidris mauri Cabanis	▬		▬		▬				▬				
Sanderling Calidris alba (Pallas)			▬		▬				▬				
Short-billed dowitcher Limnodromus griseus hendersoni Rowan; L. g. griseus (Gmelin)			▬						▬				
Wilson's phalarope Steganopus tricolor Vieillot	▬		▬		▬				▬				
Herring gull Larus argentatus smithsonianus Coues	▬		▬	▬	▬				▬				

BIRDS OF THE STUDY AREA

	SEASONAL ABUNDANCE				CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
	S	S	F	W									
Ring-billed gull Larus delawarensis Ord	▬		▬	▬	▬				▬				
Common tern Sterna hirundo hirundo Linnaeus	▬	▬	▬		╍								
Black tern Chlidonias niger surinamensis (Gmelin)	▬	▬	▬		▬				▬				
Order: Columbiformes (Pigeons and Doves)													
*Rock dove Columba livia (Gmelin)	▬	▬	▬	▬				▬					▬
*Mourning dove Zenaida macroura carolinensis (Linnaeus)	█	█	█	█		▬	▬	█	▬	▬	█	█	█
Order: Cuculiformes (Cuckoos)													
*Yellow-billed cuckoo Coccyzus americanus americanus (Linnaeus)	▬	█	▬		▬	▬	▬	▬		▬	▬		
Black-billed cuckoo Coccyzus erythropthalmus (Wilson)	▬		▬					▬		▬	▬	▬	
Order: Strigiformes (Owls)													
Barn owl Tyto alba pratincola (Bonaparte)	▬	▬	▬	▬								▬	▬
*Screech owl Otus asio naevius (Gmelin); O. a. asio (Linnaeus)	▬	▬	▬	▬		▬	▬				▬		▬
Great horned owl Bubo virginianus virginianus (Gmelin)	▬	▬	▬	▬			▬			▬			

* Barred owl
Strix varia varia Barton

Long-eared owl
Asio otus wilsonianus (Lesson)

Short-eared owl
Asio flammeus flammeus (Pontoppidan)

Order: Caprimulgiformes (Goatsuckers)

* Chuck-will's-widow
Caprimulgus carolinensis Gmelin

* Whip-poor-will
Caprimulgus vociferus vociferus Wilson

* Common nighthawk
Chordeiles minor minor (Forster)

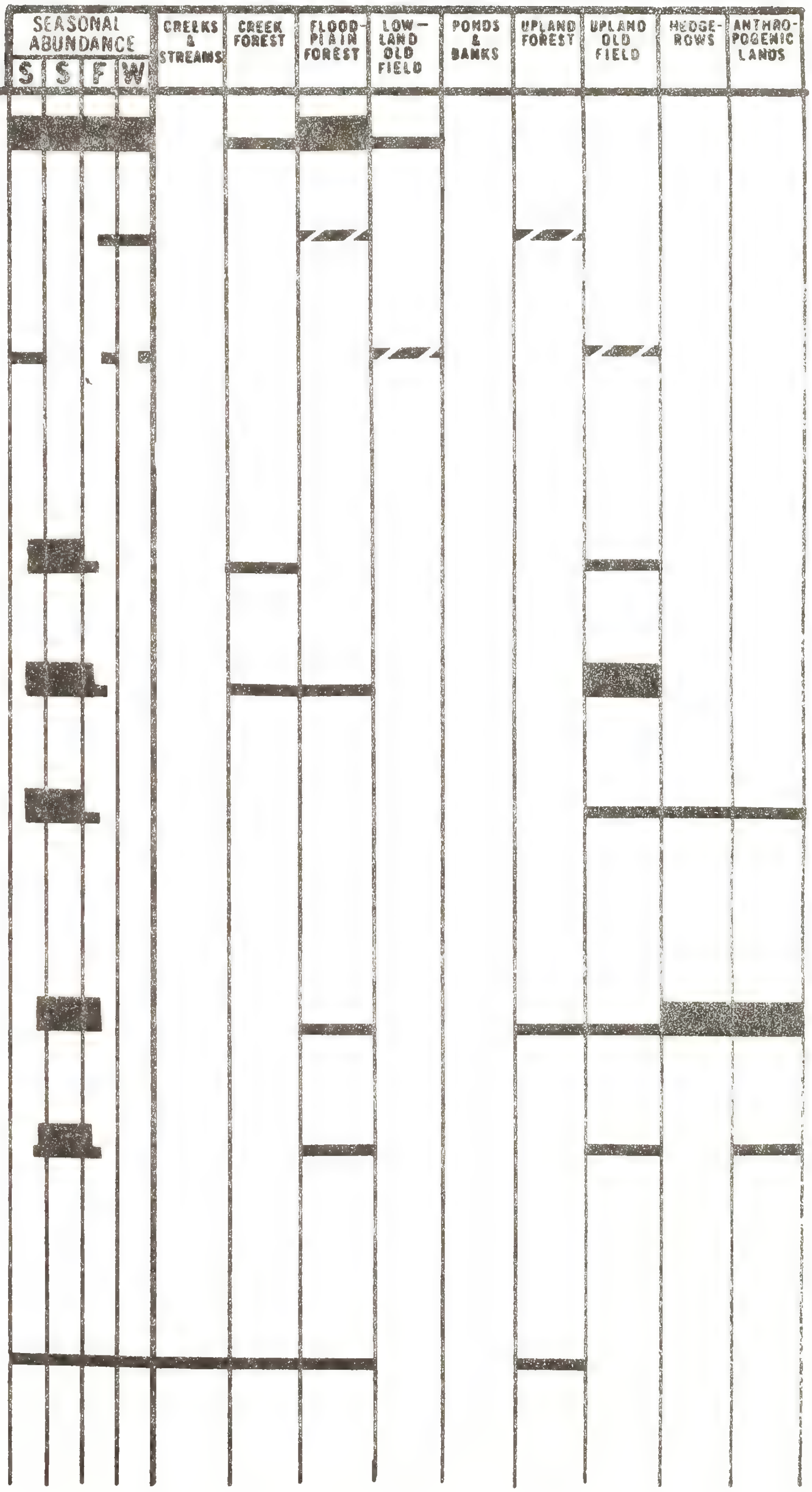
Order: Apodiformes (Swifts and Hummingbirds)

* Chimney swift
Chaetura pelagica (Linnaeus)

* Ruby-throated hummingbird
Archilochus colubris (Linnaeus)

Order: Coraciiformes (Kingfishers)

* Belted kingfisher
Megaceryle alcyon alcyon (Linnaeus)



BIRDS OF THE STUDY AREA

Order: Piciformes
(Woodpeckers)

*Common flicker
Colaptes auratus borealis Ridgway; _C. a. luteus_ Bangs

*Pileated woodpecker
Dryocopus pileatus pileatus (Linnaeus)

*Red-bellied woodpecker
Centurus carolinus zebra (Boddaert)

*Red-headed woodpecker
Melanerpes erythrocephalus erythrocephalus (Linnaeus)

*Yellow-bellied sapsucker
Sphyrapicus varius varius (Linnaeus)

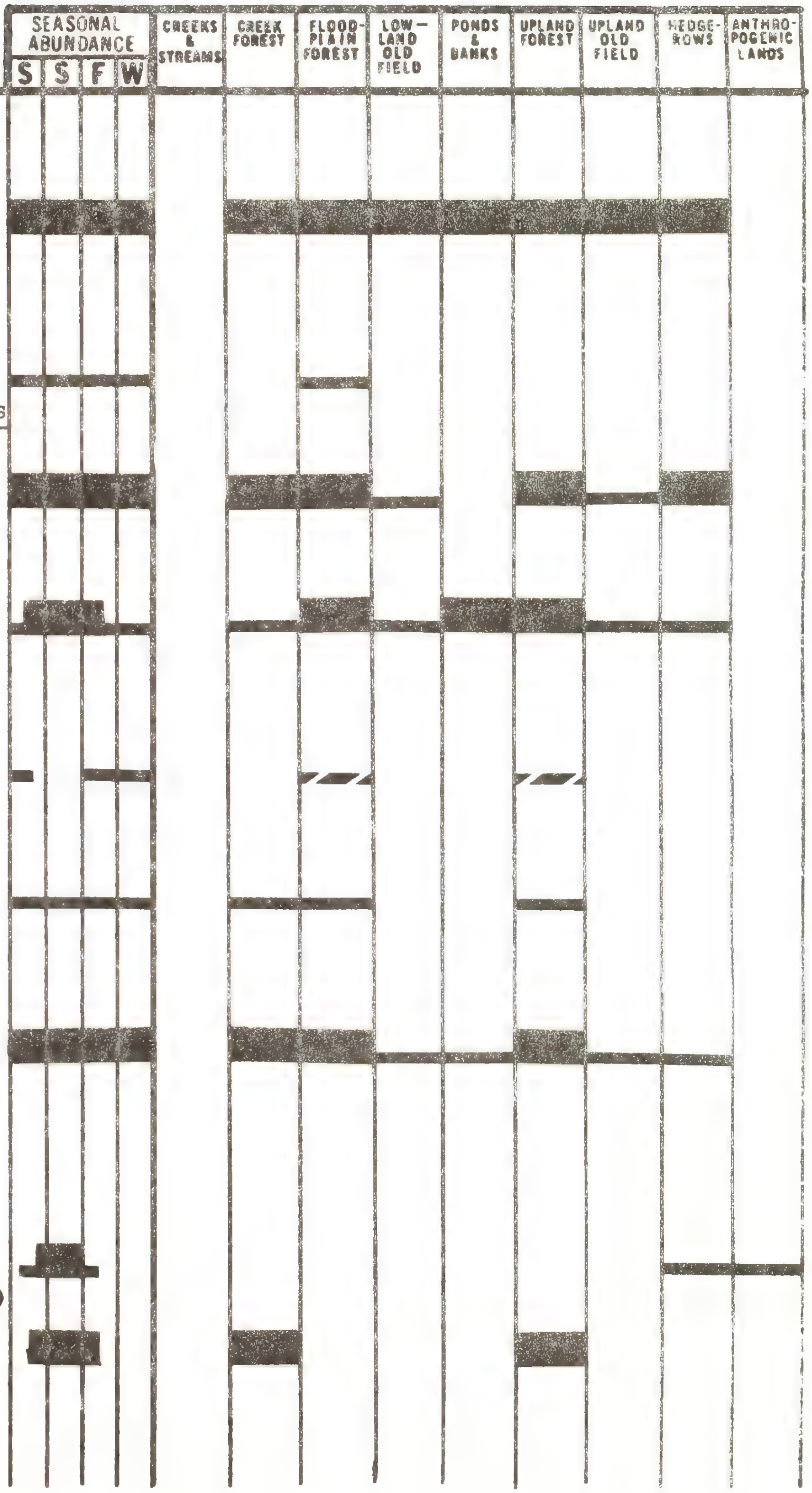
*Hairy woodpecker
Dendrocopos villosus villosus (Linnaeus); _D. v. audubonii_ (Swainson)

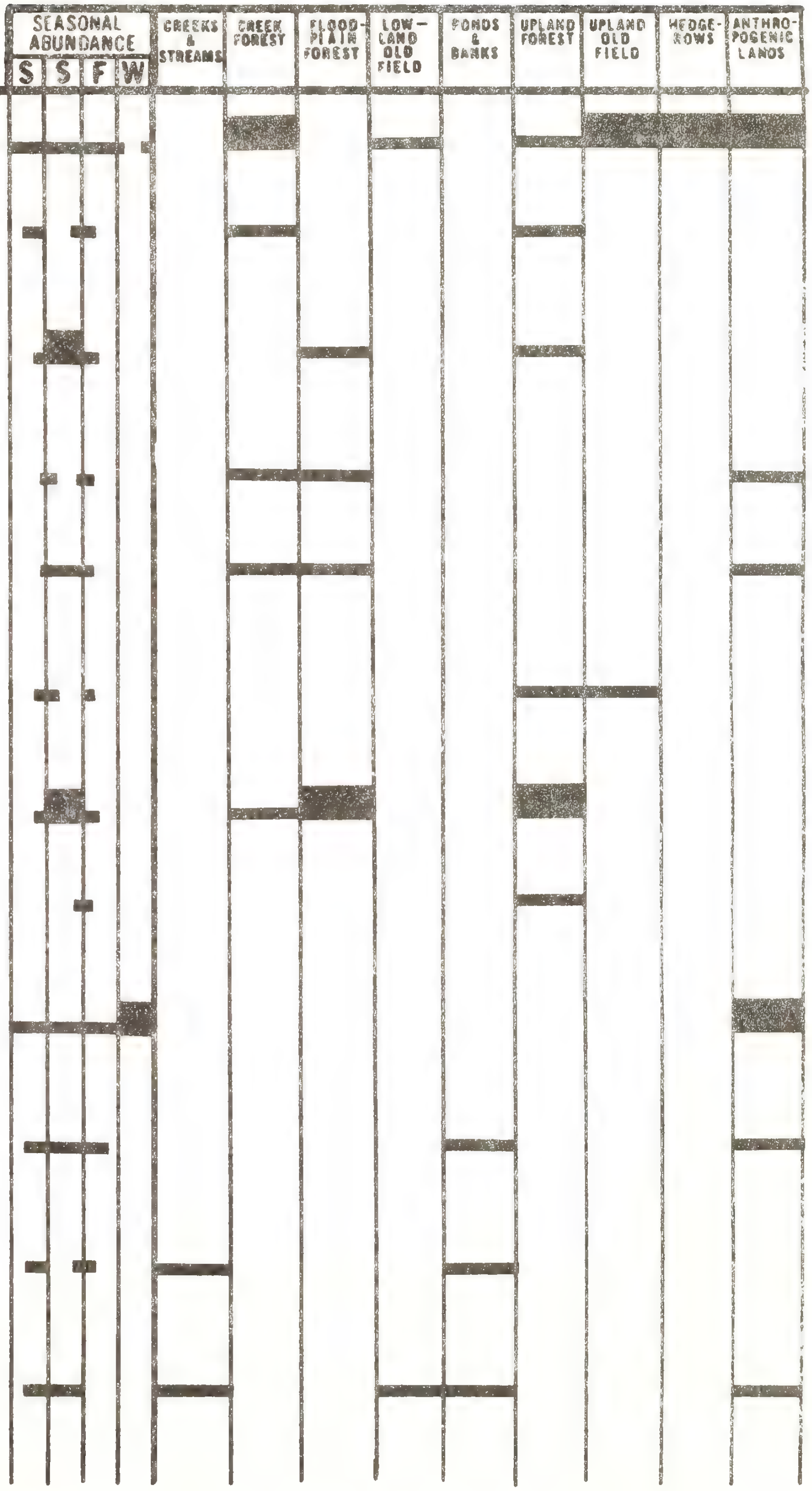
*Downy woodpecker
Dendrocopos pubescens medianus (Swainson)

Order: Passeriformes
(Perching Birds)

*Eastern kingbird
Tyrannus tyrannus (Linnaeus)

*Great crested flycatcher
Myiarchus crinitus boreus Bangs





*Eastern phoebe
Sayornis phoebe (Latham)

Yellow-bellied flycatcher
Empidonax flaviventris
(Baird & Baird)

Acadian flycatcher
Empidonax virescens
(Vieillot)

Alder flycatcher
Empidonax alnorum Brewster

*Willow flycatcher
Empidonax traillii
(Audubon)

Least flycatcher
Empidonax minimus (Baird
& Baird)

*Eastern wood pewee
Contopus virens (Linnaeus)

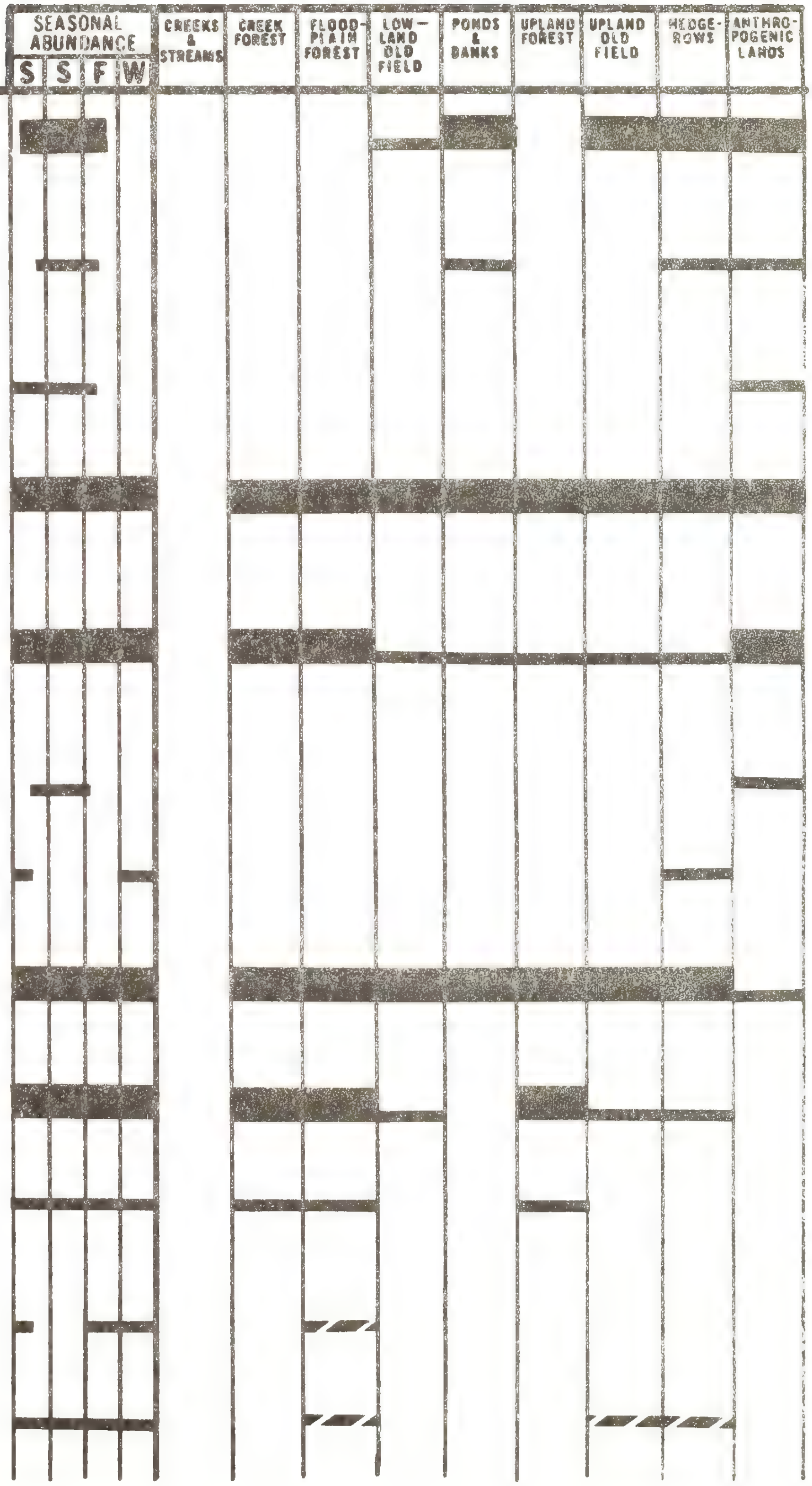
Olive-sided flycatcher
Nuttallornis borealis
(Swainson)

*Horned lark
Eremophila alpestris
praticola (Henshaw)

*Tree swallow
Iridoprocne bicolor
(Vieillot)

Bank swallow
Riparia riparia riparia
(Linnaeus)

Rough-winged swallow
Stelgidopteryx ruficollis
serripennis (Audubon)



*Barn swallow
Hirundo rustica erythrogaster Boddaert

*Cliff swallow
Petrochelidon pyrrhonota pyrrhonota (Vieillot)

*Purple martin
Progne subis subis (Linnaeus)

*Blue jay
Cyanocitta cristata bromia Oberholser; *C. c. cristata* (Linnaeus)

*Common crow
Corvus brachyrhynchos brachyrhynchos Brehm

Fish crow
Corvus ossifragus Wilson

Black-capped chickadee
Parus atricapillus atricapillus Linnaeus

*Carolina chickadee
Parus carolinensis extimus (Todd & Sutton)

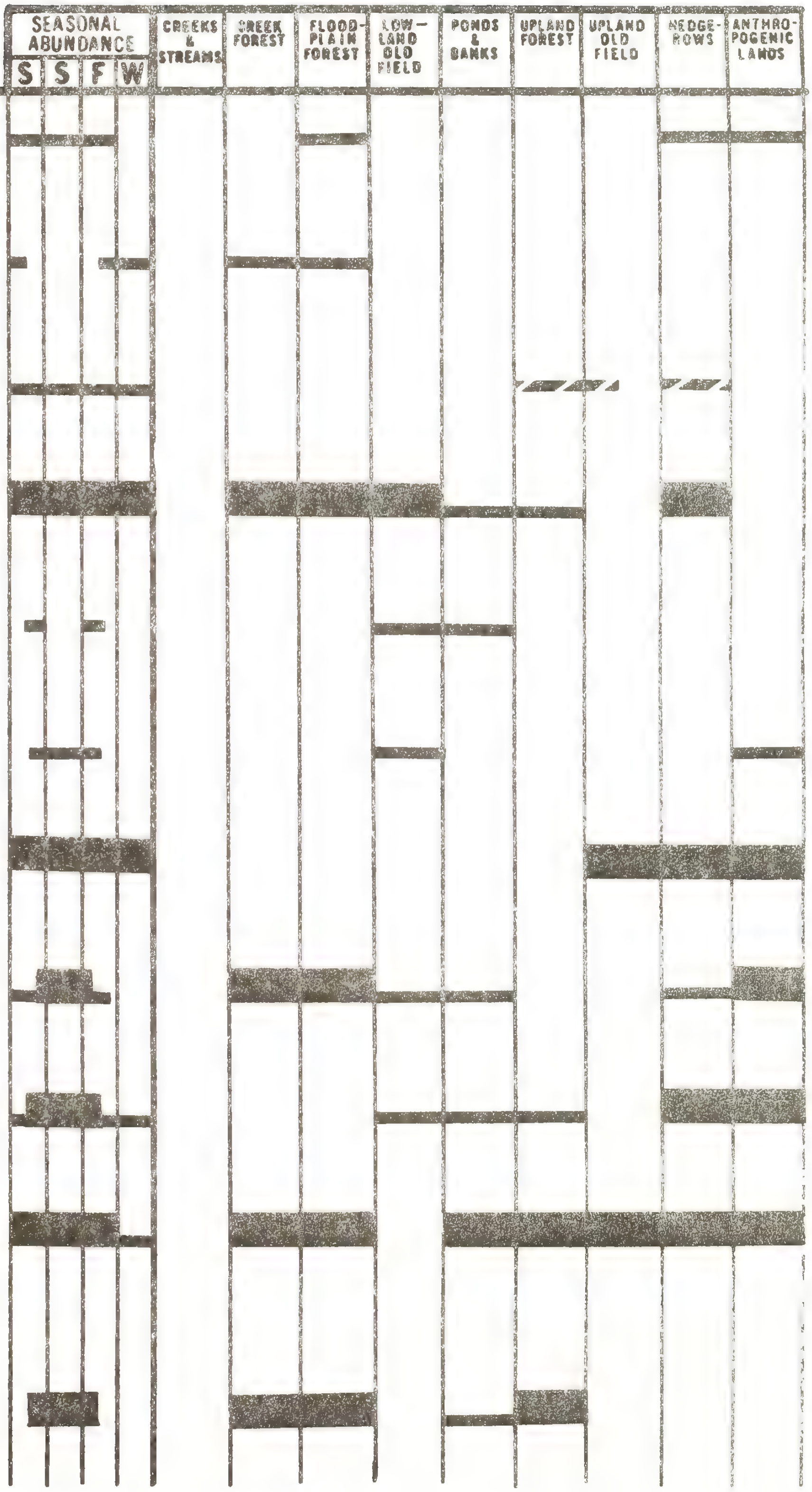
*Tufted titmouse
Parus bicolor Linnaeus

*White-breasted nuthatch
Sitta carolinensis cookei Oberholser

Red-breasted nuthatch
Sitta canadensis Linnaeus

*Brown creeper
Certhia familiaris americana Bonaparte

BIRDS OF THE STUDY AREA



* House wren
Troglodytes aedon baldwini
Oberholser

* Winter wren
Troglodytes troglodytes
hiemalis Vieillot

* Bewick's wren
Thryomanes bewickii
bewickii (Audubon)

* Carolina wren
Thryothores ludovicianus
ludovicianus (Latham)

Long-billed marsh wren
Telmatodytes palustris
dissaeptus (Bangs)

Short-billed marsh wren
Cistothorus platensis
stellaris (Naumann)

* Mockingbird
Mimus polyglottos
polyglottos (Linnaeus)

* Gray catbird
Dumetella carolinensis
(Linnaeus)

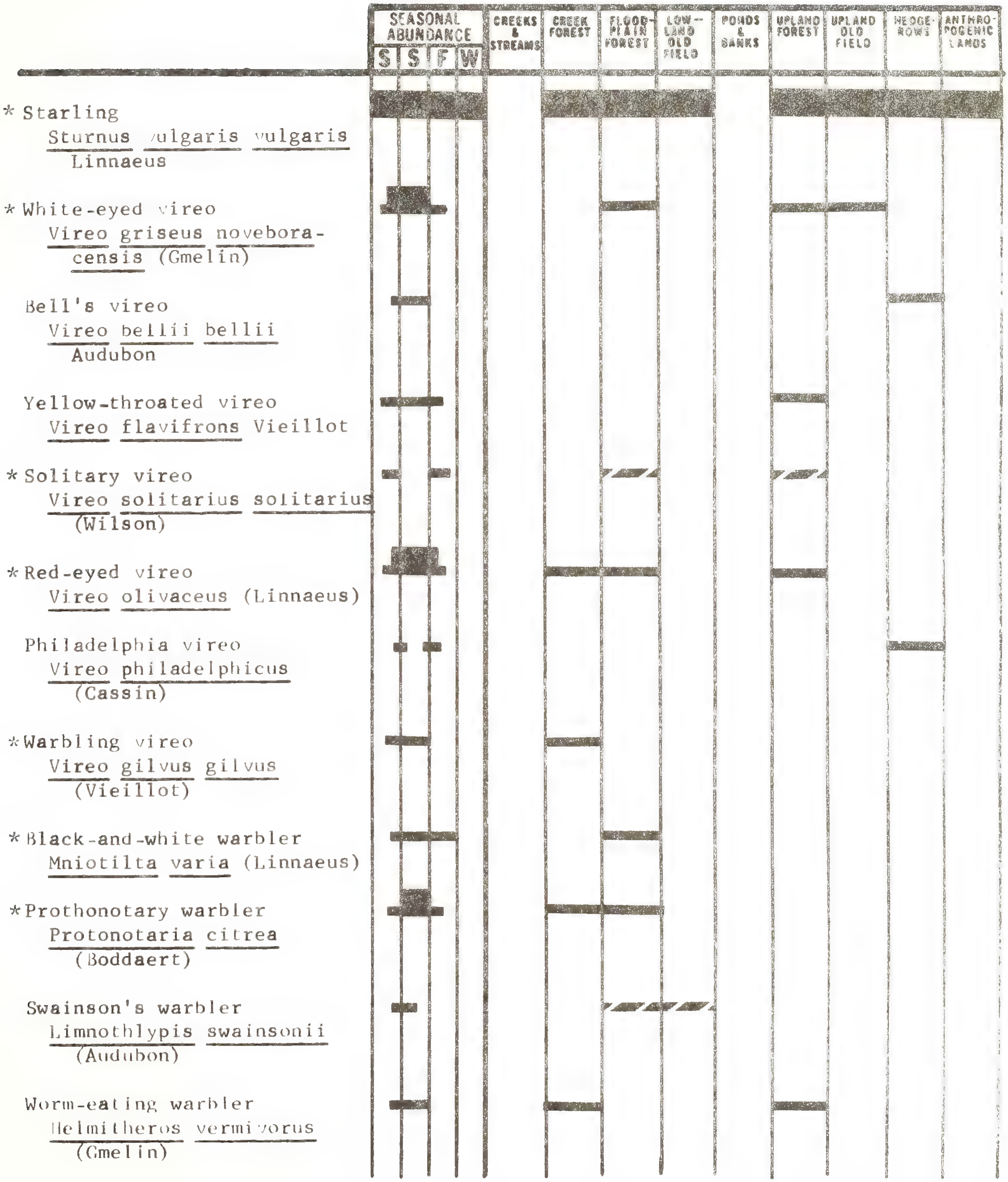
* Brown thrasher
Toxostoma rufum rufum
(Linnaeus)

* American robin
Turdus migratorius
migratorius Linnaeus;
T. m. achrusterus
(Batchelder)

* Wood thrush
Hylocichla mustelina
(Gmelin)

	SEASONAL ABUNDANCE				CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
	S	S	F	W									
*Hermit thrush Catharus guttatus faxoni Bangs & Penard	—		—	—						—		—	
*Swainson's thrush Catharus ustulatus swainsoni (Tschudi)	—		—				—			—			
*Gray-cheeked thrush Catharus minimus minimus (Lafresnaye)	—		—			—	—			—			
*Veery Catharus fuscescens fuscescens (Stephens); C. f. salicicola Ridgway	—		—			- -	- -			- -			
*Eastern bluebird Sialia sialis sialis (Linnaeus)	▬	▬	—	—		—	—	—		—	—	—	—
*Blue-gray gnatcatcher Polioptila caerulea caerulea (Linnaeus)	▬	▬					—						
*Golden-crowned kinglet Regulus satrapa satrapa Lichtenstein	—		—	—		—	—			—			
*Ruby-crowned kinglet Regulus calendula calendula (Linnaeus)	—		—	—		—	—			—			
Water pipit Anthus spinoletta rubescens (Tunstall)	—		—										—
Cedar waxwing Bombycilla cedrorum Vieillot	—	—	—	—								—	—
* Loggerhead shrike Lanius ludovicianus migrans Palmer	—	—	—	—				- -			- -	- -	- -

BIRDS OF THE STUDY AREA



* Starling
Sturnus vulgaris vulgaris
Linnaeus

* White-eyed vireo
Vireo griseus novebora-censis (Gmelin)

Bell's vireo
Vireo bellii bellii
Audubon

Yellow-throated vireo
Vireo flavifrons Vieillot

* Solitary vireo
Vireo solitarius solitarius
(Wilson)

* Red-eyed vireo
Vireo olivaceus (Linnaeus)

Philadelphia vireo
Vireo philadelphicus
(Cassin)

* Warbling vireo
Vireo gilvus gilvus
(Vieillot)

* Black-and-white warbler
Mniotilta varia (Linnaeus)

* Prothonotary warbler
Protonotaria citrea
(Boddaert)

Swainson's warbler
Limnothlypis swainsonii
(Audubon)

Worm-eating warbler
Helmitheros vermivorus
(Gmelin)

	SEASONAL ABUNDANCE S	S	F	W	CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
Golden-winged warbler __Vermivora chrysoptera__ (Linnaeus)	▬		▬					▬		▬	▬	▬	
Blue-winged warbler __Vermivora pinus__ (Linnaeus)	▬	▬	▬					▬			▬	▬	
* Tennessee warbler __Vermivora peregrina__ (Wilson)	▬		▬			▬	▬			▬			
Orange-crowned warbler __Vermivora celata celata__ (Say)	▬		▬			▬						▬	
* Nashville warbler __Vermivora ruficapilla ruficapilla__ (Wilson)	▬		▬			▨	▨		▨	▨	▨		
* Northern parula warbler __Parula americana__ (Linnaeus)	▬	▬	▬			▬	▬			▬			
* Yellow warbler __Dendroica petechia aestiva__ (Gmelin); __D. p. amnicola__ Batchelder	▬	▬	▬			▬	▬	▬				▬	
* Magnolia warbler __Dendroica magnolia__ (Wilson)	▬		▬				▬			▬			
Cape May warbler __Dendroica tigrina__ (Gmelin)	▬		▬									▬	
Black-throated blue warbler __Dendroica caerulescens caerulescens__ (Gmelin)	▬		▬							▬			
* Black-throated green warbler __Dendroica virens virens__ (Gmelin)	▬		▬							▬			
* Yellow-rumped warbler __Dendroica coronata coronata__ (Linnaeus)	█		█	▬		█	█			█			

Cerulean warbler
Dendroica cerulea (Wilson)

Blackburnian warbler
Dendroica fusca (Muller)

Yellow-throated warbler
Dendroica dominica albilora Ridgway

Chestnut-sided warbler
Dendroica pensylvanica (Linnaeus)

Bay-breasted warbler
Dendroica castanea (Wilson)

Blackpoll warbler
Dendroica striata (Forster)

Pine warbler
Dendroica pinus pinus (Wilson)

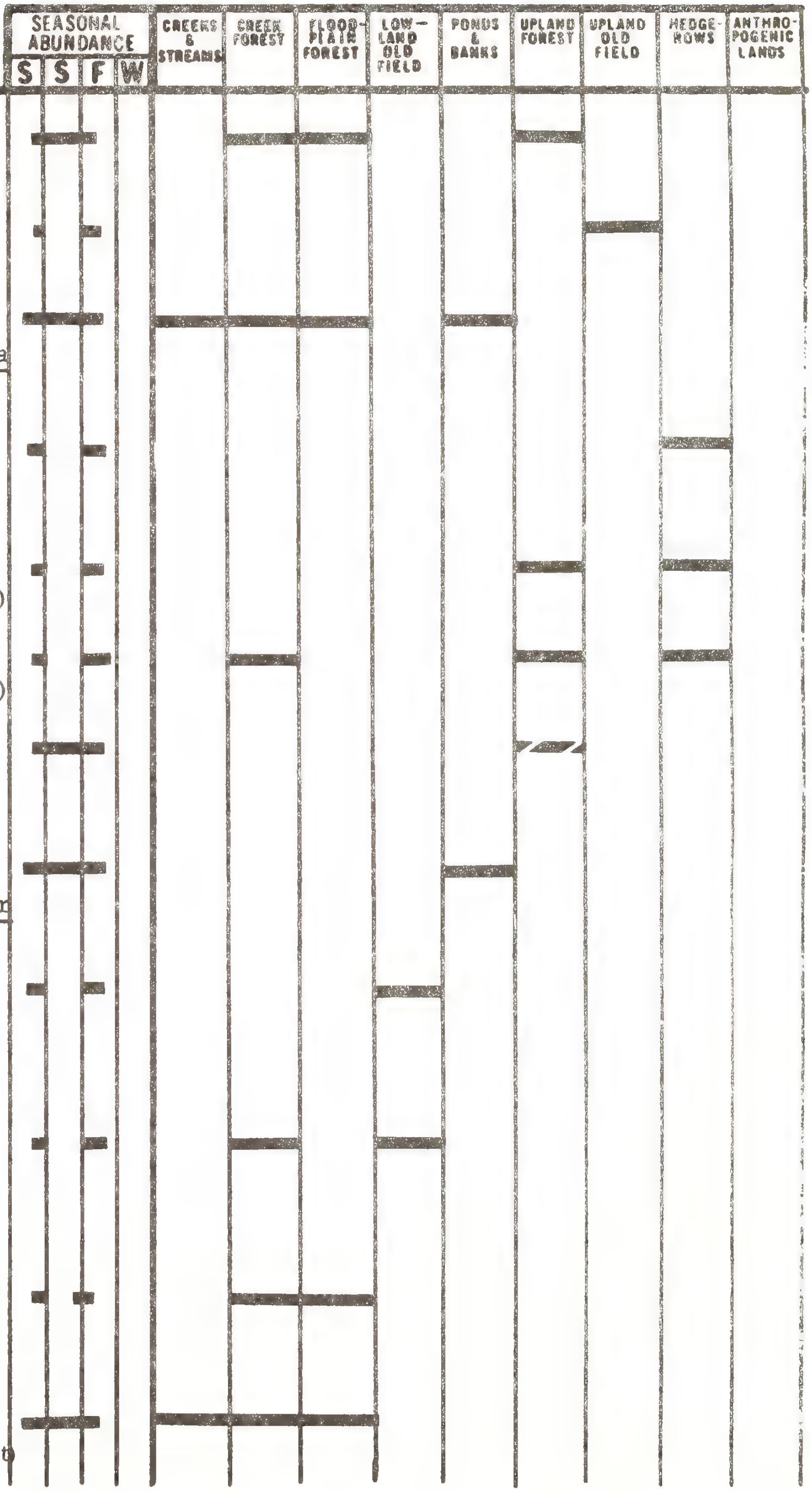
*Prairie warbler
Dendroica discolor discolor (Vieillot)

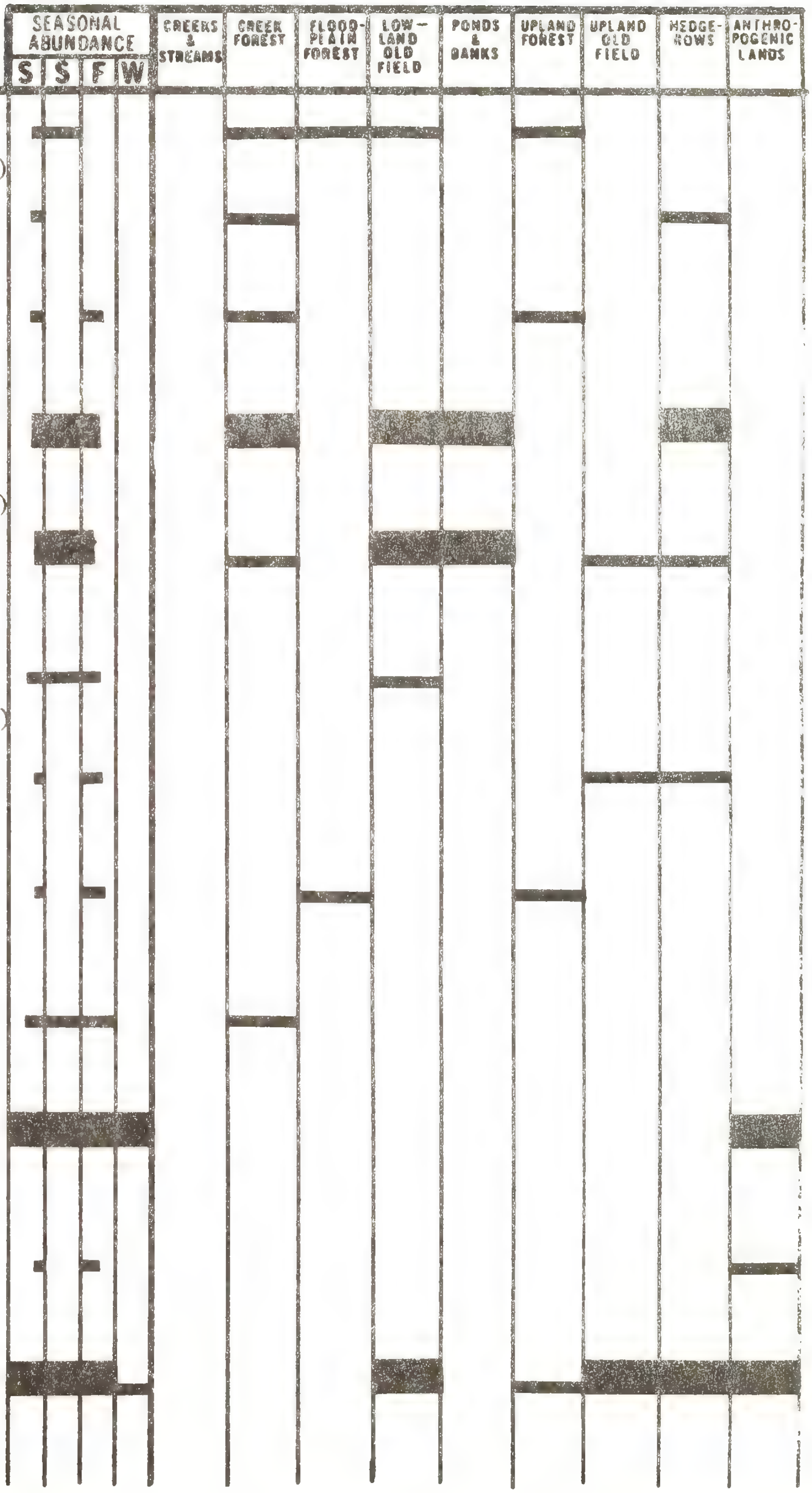
*Palm warbler
Dendroica palmarum palmarum (Gmelin); *D. p. hypochrysea* Ridgway

*Ovenbird
Seiurus aurocapillus aurocapillus (Linnaeus); *S. a. cinereus* Miller

*Northern waterthrush
Seiurus noveboracensis notabilis Ridgway

*Louisiana waterthrush
Seiurus motacilla (Vieillot)





*Kentucky warbler
Oporornis formosus (Wilson)

Connecticut warbler
Oporornis agilis (Wilson)

*Mourning warbler
Oporornis philadelphia
(Wilson)

*Common yellowthroat
Geothlypis trichas
brachidactylus (Swainson)

*Yellow-breasted chat
Icteria virens virens
(Linnaeus)

Hooded warbler
Wilsonia citrina (Boddaert)

Wilson's warbler
Wilsonia pusilla pusilla
(Wilson)

Canada warbler
Wilsonia canadensis
(Linnaeus)

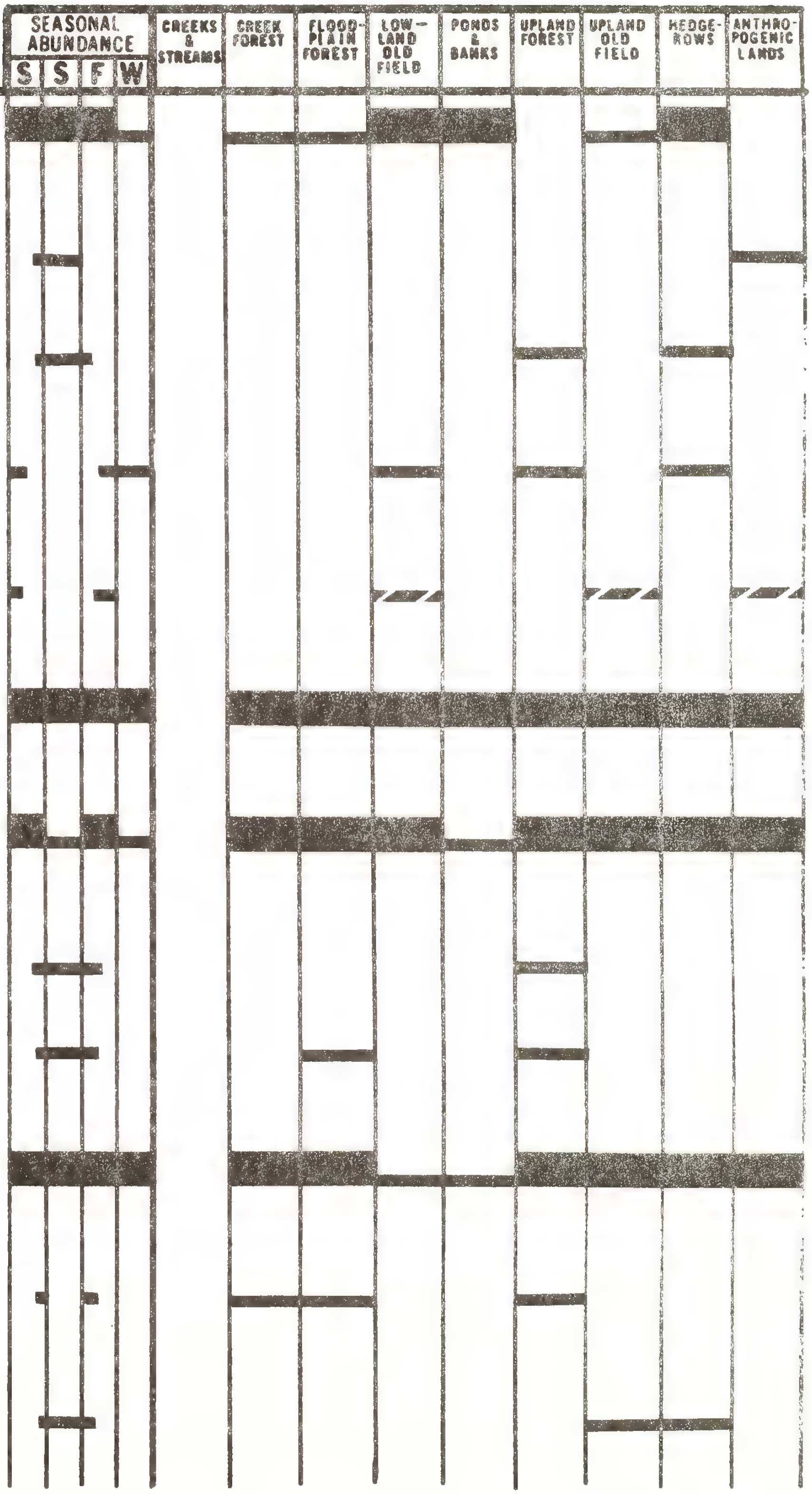
*American redstart
Setophaga ruticilla
ruticilla (Linnaeus)

*House sparrow
Passer domesticus
domesticus (Linnaeus)

*Bobolink
Dolichonyx oryzivorus
(Linnaeus)

*Eastern meadowlark
Sturnella magna magna
(Linnaeus); S. m.
argutula Bangs

BIRDS OF THE STUDY AREA



* Red-winged blackbird
Agelaius phoeniceus phoeniceus (Linnaeus)

* Orchard oriole
Icterus spurius (Linnaeus)

* Northern oriole
Icterus galbula galbula (Linnaeus)

* Rusty blackbird
Euphagus carolinus carolinus (Muller)

Brewer's blackbird
Euphagus cyanocephalus (Wagler)

* Common grackle
Quiscalus quiscula versicolor Vieillot

* Brown-headed cowbird
Molothrus ater ater (Boddaert)

* Scarlet tanager
Piranga olivacea (Gmelin)

* Summer tanager
Piranga rubra rubra (Linnaeus)

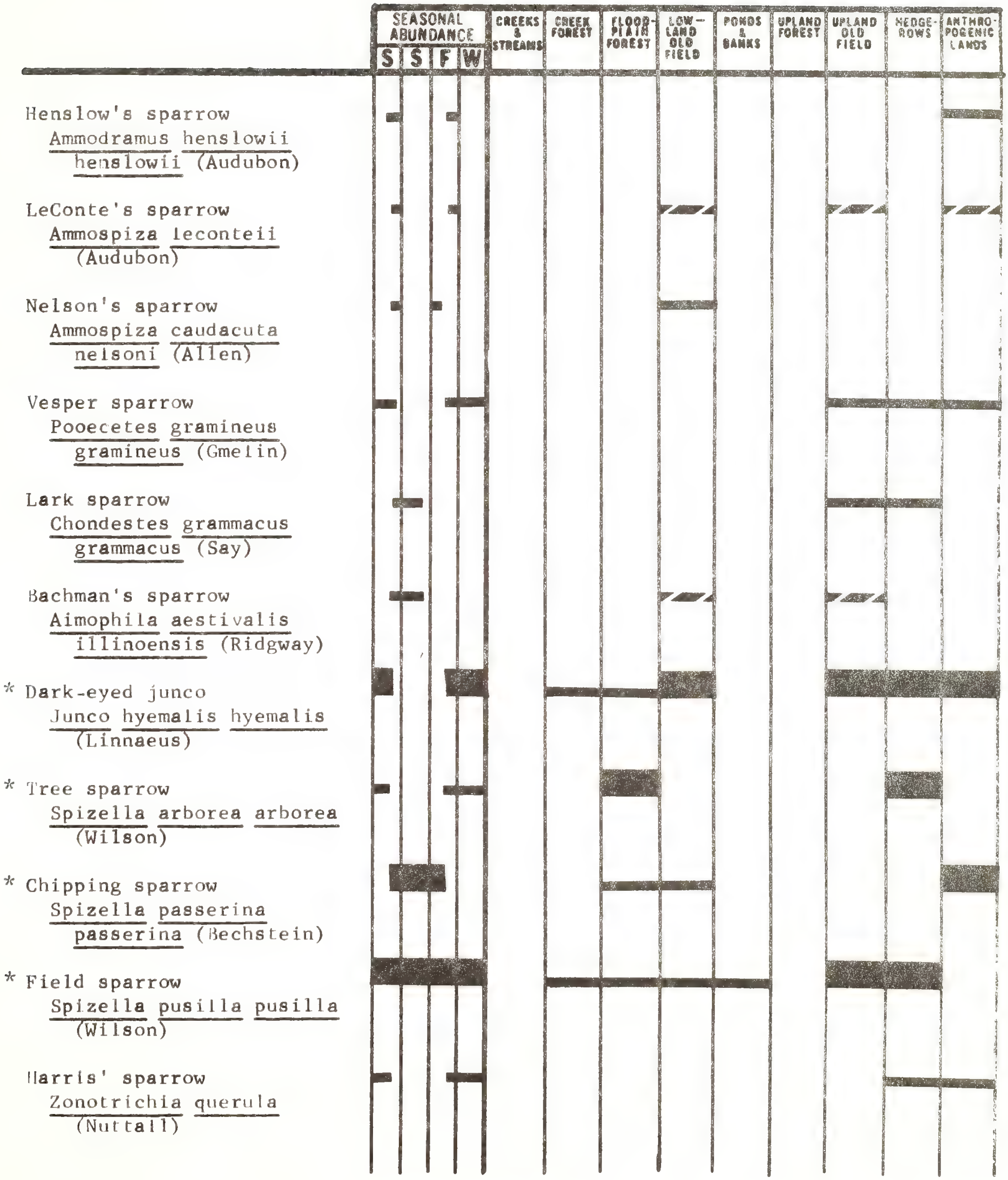
* Cardinal
Cardinalis cardinalis cardinalis (Linnaeus)

* Rose-breasted grosbeak
Pheucticus ludovicianus (Linnaeus)

* Blue grosbeak
Guiraca caerulea caerulea (Linnaeus)

BIRDS OF THE STUDY AREA

	SEASONAL ABUNDANCE				CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
	S	S	F	W									
* Indigo bunting *Passerina cyanea* (Linnaeus)	▬	▬				—	—	▬	▬	—	▬	▬	▬
* Dickcissel *Spiza americana* (Gmelin)	—	▬						—					▬
Evening grosbeak *Hesperiphona vespertina vespertina* (Cooper)	—		—	—			—						—
* Purple finch *Carpodacus purpureus purpureus* (Gmelin)	—		—	▬		—	—					▬	▬
Pine siskin *Spinus pinus pinus* (Wilson)	—		—	—								—	
* American goldfinch *Spinus tristis tristis* (Linnaeus)	▬	▬	▬	▬			▬	▬	—	—	▬	▬	▬
Red crossbill *Loxia curvirostra minor* (Brehm)			—	—			—						
White-winged crossbill *Loxia leucoptera leucoptera* Gmelin				—			—						
* Rufous-sided towhee *Pipilo erythrophthalmus erythrophthalmus* (Linnaeus)	▬	▬	▬	—		—	—	▬		—	▬	▬	
Savannah sparrow *Passerculus sandwichensis labradorius* Howe; *P. s. savanna* (Wilson); *P. s. oblitus* Peters & Griscom	—		—					—					—
* Grasshopper sparrow *Ammodramus savannarum pratensis* (Vieillot)	▬	▬						—			—		—


SEASONAL ABUNDANCE
S
S
F
W
CREEKS & STREAMS
CREEK FOREST
FLOOD-PLAIN FOREST
LOW-LAND OLD FIELD
PONDS & BANKS
UPLAND FOREST
UPLAND OLD FIELD
HEDGE-ROWS
ANTHRO-POGENIC LANDS
Henslow's sparrow
Ammodramus henslowii henslowii (Audubon)
LeConte's sparrow
Ammospiza leconteii (Audubon)
Nelson's sparrow
Ammospiza caudacuta nelsoni (Allen)
Vesper sparrow
Pooecetes gramineus gramineus (Gmelin)
Lark sparrow
Chondestes grammacus grammacus (Say)
Bachman's sparrow
Aimophila aestivalis illinoensis (Ridgway)
* Dark-eyed junco
Junco hyemalis hyemalis (Linnaeus)
* Tree sparrow
Spizella arborea arborea (Wilson)
* Chipping sparrow
Spizella passerina passerina (Bechstein)
* Field sparrow
Spizella pusilla pusilla (Wilson)
Harris' sparrow
Zonotrichia querula (Nuttall)

* White-crowned sparrow
Zonotrichia leucophrys leucophrys (Forster)

* White-throated sparrow
Zonotrichia albicollis (Gmelin)

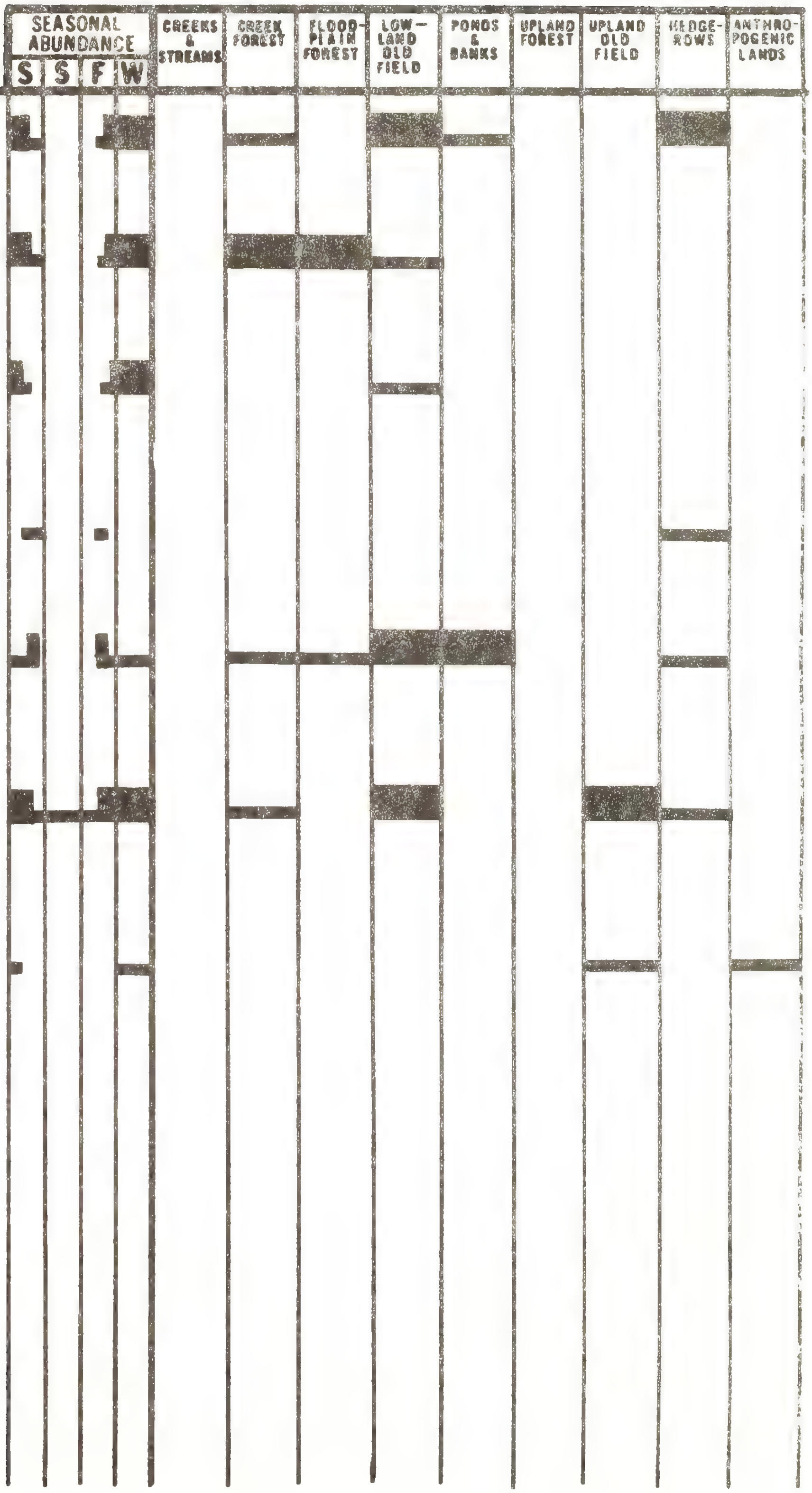
* Fox sparrow
Passerella iliaca iliaca (Merrem); *P. i. zaboria* Oberholser

Lincoln's sparrow
Melospiza lincolnii lincolnii (Audubon)

* Swamp sparrow
Melospiza georgiana ericrypta Oberholser; *M. g. georgiana* (Latham)

* Song sparrow
Melospiza melodia melodia (Wilson); *M. m. euphonia* Wetmore

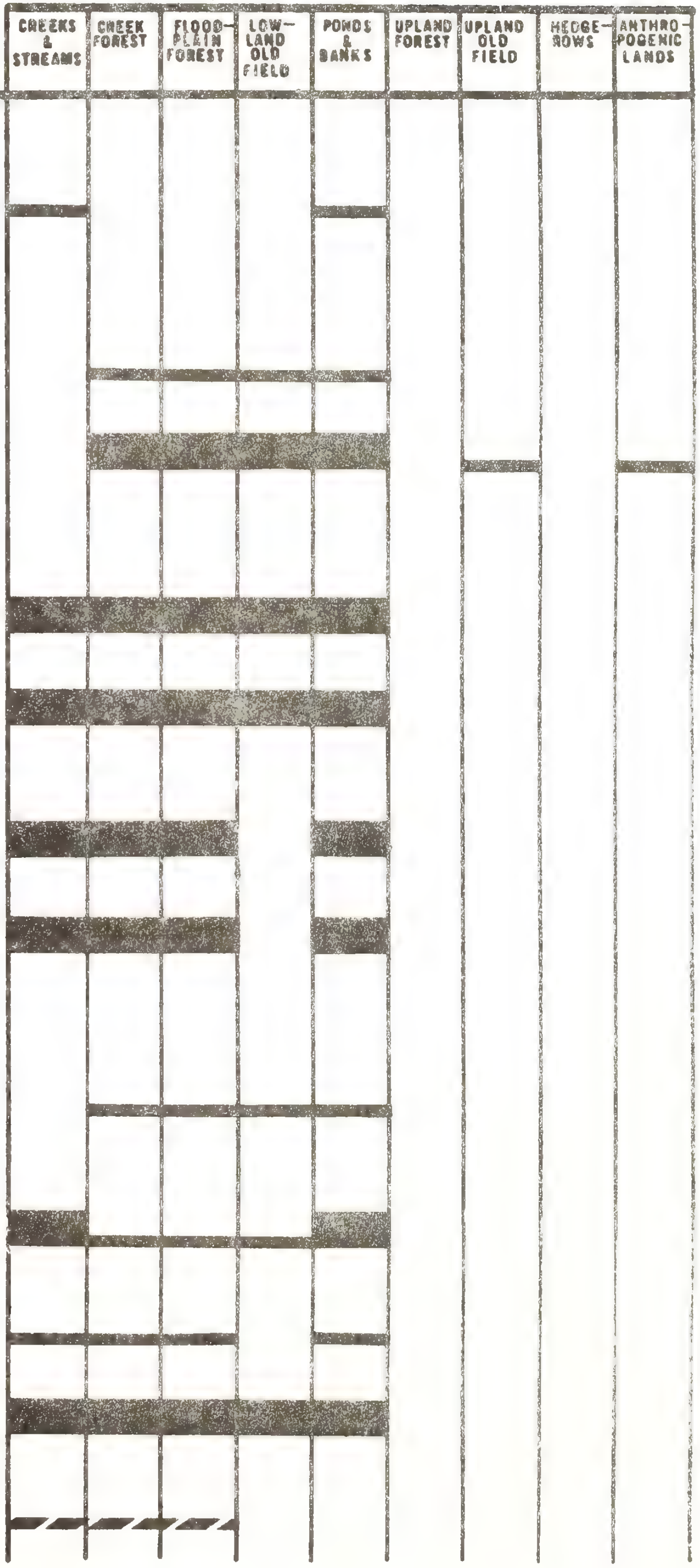
Lapland longspur
Calcarius lapponicus lapponicus (Linnaeus)



AMPHIBIANS AND REPTILES OF THE STUDY AREA

	CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
Family: Ambystomatidae (Mole Salamanders)									
*Spotted salamander *Ambystoma maculatum* (Shaw)	─	▬	▬		▬				
Marbled salamander *Ambystoma opacum* (Gravenhorst)	▬	▬	▬	▬	▬	─			
*Small-mouthed salamander *Ambystoma texanum* (Matthes)	▬	▬	▬	▬	▬				
Eastern tiger salamander *Ambystoma tigrinum tigrinum* (Green)	─	─	─	─	▬				─
Family: Salamandridae (Newts)									
Central newt *Notophthalmus viridescens louisianensis* (Wolterstorff)	─	─	─		─				
Family: Plethodontidae (Long-tailed Salamanders)									
Midwest two-lined salamander *Eurycea bislineata rivicola* Mittleman	─	─			─				
Long-tailed salamander *Eurycea longicauda longicauda* (Green)	─	─							
Cave salamander *Eurycea lucifuga* Rafinesque	─	─							
Zigzag salamander *Plethodon dorsalis* Cope		▬	▬		▬	▬			
*Slimy salamander *Plethodon glutinosus glutinosus* (Green)		▬	▬			▬			
Family: Proteidae (Giant Salamanders)									
Mud puppy *Necturus maculosus maculosus* (Rafinesque)	▬				▬				

AMPHIBIANS AND REPTILES OF THE STUDY AREA



Family: Sirenidae (Sirens)

Western lesser siren
Siren intermedia nettingi Goin

Family: Bufonidae (Toads)

* Dwarf American toad
Bufo americanus charlesmithi Bragg

* Fowler's toad
Bufo woodhousei fowleri Hinckley

Family: Hylidae (Treefrogs and Allies)

* Blanchard's cricket frog
Acris crepitans blanchardi Harper

* Upland chorus frog
Pseudacris triseriata feriarum (Baird)
x *triseriata* (Wied)

* Northern spring peeper
Hyla crucifer crucifer Wied

* Eastern gray treefrog
Hyla versicolor versicolor Le Conte

Family: Ranidae (True Frogs)

Northern crayfish frog
Rana aereolata circulosa Rice and Davis

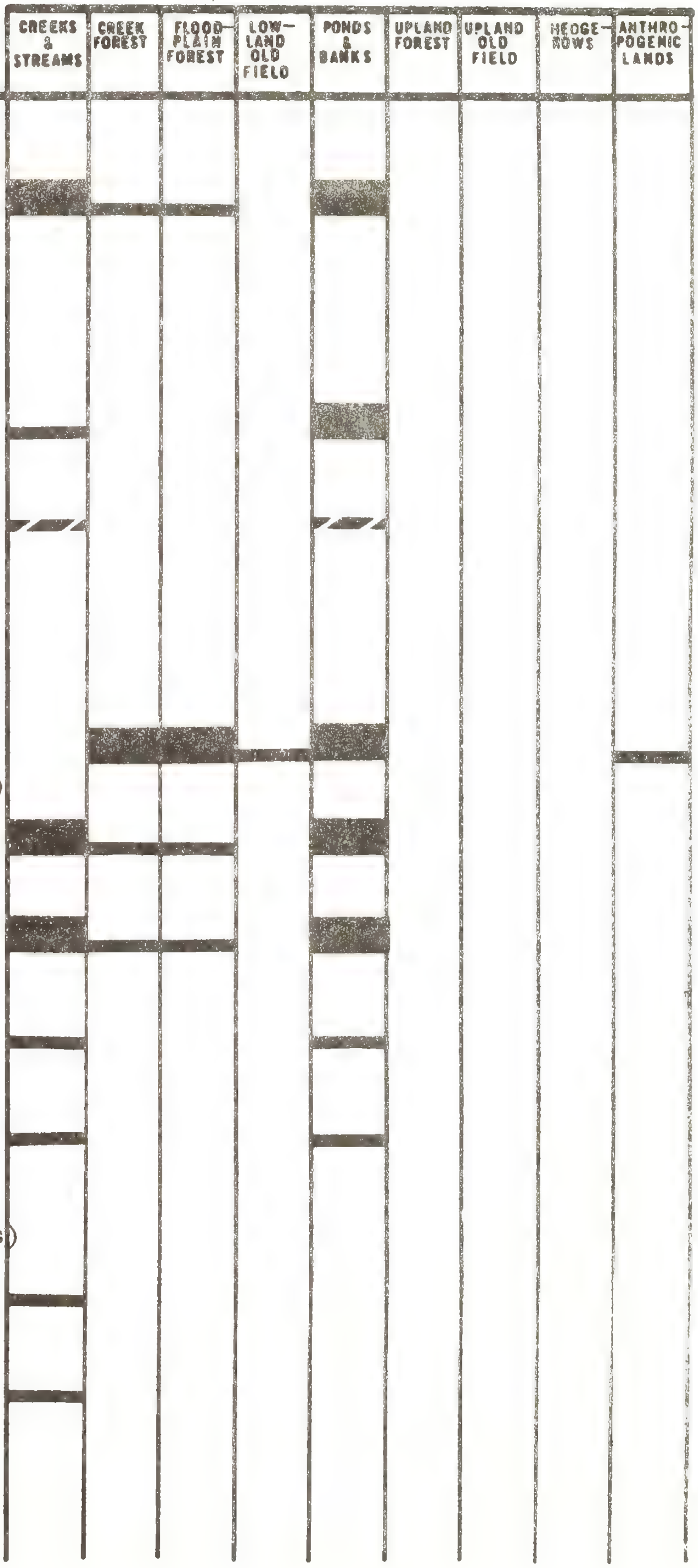
* Bullfrog
Rana catesbeiana Shaw

* Green frog
Rana clamitans melanota (Rafinesque)

* Southern leopard frog
Rana pipiens sphenocephala Cope

Eastern wood frog
Rana sylvatica sylvatica Le Conte

AMPHIBIANS AND REPTILES OF THE STUDY AREA



Family: Chelydridae (Snapping Turtles)

*Common snapping turtle
Chelydra serpentina serpentina
(Linnaeus)

Family: Kinosternidae (Musk and Mud Turtles)

Stinkpot
Sternothaerus odoratus (Latrielle)

Mud turtle
Kinosternon subrubrum subrubrum
(Lacepede) x *hippocrepis* Gray

Family: Testudinidae (Box and Water Turtles)

*Eastern box turtle
Terrapene carolina carolina (Linnaeus)

*Midland painted turtle
Chrysemys picta marginata Agassiz

*Red-eared turtle
Pseudemys scripta elegans (Wied)

False map turtle
Graptemys pseudogeographica (Gray)

*Map turtle
Graptemys geographica (La Sueur)

Family: Trionychidae (Softshell Turtles)

Smooth softshell
Trionyx muticus muticus La Sueur

*Eastern spiny softshell
Trionyx spinifer spinifer La Sueur

AMPHIBIANS AND REPTILES OF THE STUDY AREA

	CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
Family: Iguanidae (Iguanids)									
*Northern fence lizard *Sceloporus undulatus hyacinthinus* (Green)						▬	▬	▬	─
Family: Anguidae (Glass Lizards)									
Western slender glass lizard *Ophisaurus attenuatus attenuatus* Cope						- -	- -		
Family: Teiidae (Whiptails)									
*Six-lined racerunner *Cnemidophorus sexlineatus sexlineatus* (Linnaeus)						▬	▬	▬	─
Family: Scincidae (Skinks)									
*Ground skink *Scincella laterale* (Say)		─				▬	─	─	
*Five-lined skink *Eumeces fasciatus* (Linnaeus)		▬	─			▬			─
Broad-headed skink *Eumeces laticeps* (Schneider)		▬	▬			▬			
Family: Colubridae (Colubrids)									
Midwest worm snake *Carphophis amoenus helenae* (Kennicott)		─	─			─			
Western mud snake *Farancia abacura reinwardti* (Schlegel)			─		─				
Northern ringneck snake *Diadophis punctatus edwardsi* (Merrem)		─	─			─	─		
*Eastern hognose snake *Heterodon platyrhinos* Latrielle			─	▬		▬	▬	─	
*Rough green snake *Opheodrys aestivus* (Linnaeus)		▬		▬	▬				

AMPHIBIANS AND REPTILES OF THE STUDY AREA

	CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
*Eastern yellow-bellied racer *Coluber constrictor flaviventris* Say x *priapus*		■	—	■	—	■	■	■	
*Black rat snake *Elaphe obsoleta obsoleta* (Say) x *spiloides* Dumeril, Bibron and Dumeril		■	■	■	■	■	■	■	—
*Prairie kingsnake *Lampropeltis calligaster calligaster* (Harlan)				■	—		■	■	
Black kingsnake *Lampropeltis getulus niger* (Yarrow)		■				■	—	—	
Red milk snake *Lampropeltis triangulum syspila* (Cope)						—	—		
*Eastern garter snake *Thamnophis sirtalis sirtalis* (Linnaeus)		■	—	■	■	—	■	■	
Western earth snake *Virginia valeriae elegans* Kennicott		—	—			—			
Midland brown snake *Storeria dekayi wrightorum* Trapido		—	—	—		—	—		
Northern red-bellied snake *Storeria occipitomaculata occipitomaculata* (Storer)		—	—	—		—			
*Northern copperbelly *Natrix erythrogaster neglecta* Conant	—			—	■				
Diamond-backed water snake *Natrix rhombifera rhombifera* (Hallowell)	—				■				
*Midland water snake *Natrix sipedon pleuralis* Cope	■				■				

AMPHIBIANS AND REPTILES OF THE STUDY AREA

	CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
Family: Crotalidae (Crotalids)									
*Northern copperhead *Agkistrodon contortrix mokeson* (Daudin)			▬	■		■			
Timber rattlesnake *Crotalus horridus horridus* Linnaeus						╌	╌		

APPENDIX G

Terrestrial Macroinvertebrates Collected in the Delta Expansion Area

	Number Collected								
	CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
CLASS ARACHNIDA (Spiders and Mites)									
Order: Araneae									
Family: Anyphaenidae (Anyphaenids)									
Anyphaena sp.		2							
Wulfila saltabunda			1	2	2			5	
Family: Araneidae (Orb-weavers)			10	2	24	1	2	11	
Acacesia hamata			3	1	3	1	7	3	
Acanthepeira stellata				3	1			2	
Araneus pratensis				6			5		
Argiope aurantia							1		
Argiope trifasciata							1		
Leucauge venusta		3	1						
Mangora gibberosa				4			14	2	
Mangora maculata		2	2			3			
Mangora placida		5	5		4	2		4	
Micrathena sp.			2		2				
Micrathena gracilis		1							
Micrathena sagittata		1							
Neoscona sp.		1			1				
Neoscona arabesca					1		1		
Tetragnatha sp.		1							
Tetragnatha laboriosa		2	1		17			9	
Tetragnatha pallescens		3	6						
Verrucosa arenata		1							
Family: Clubionidae (Clubionids)									
Clubiona sp.				1					
Trachelas deceptus								1	
Family: Dictynidae (Dictynids)									
Dictyna sp.		1				2	1		
Dictyna cruciata		12			1				
Dictyna foliacea							1	8	
Dictyna orbiculata			1						
Dictyna sublata			4		1	1			
Dictyna volucripes				1	5		2		

	CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
Family: Gnaphosidae (Gnaphosids)									
Sergiolus sp.								1	
Sergiolus famulus					1				
Family: Linyphiidae (Sheet-web Weavers)					1				
Ceraticelus sp.					1		1		
Ceraticelus creolus		1							
Ceraticelus fissiceps		1				1			
Ceratinopsis sp.		1	2						
Ceratinopsis purpurescens						5			
Cornicularia sp.								1	
Eperigone tridentata						1			
Florinda coccinea								1	
Frontinella pyramitela								1	
Family: Lycosidae (Hunting Spiders)				1					
Arctosa funerea				10	2			2	
Lycosa sp.					1			1	
Pardosa sp.			1						
Pardosa milvina								3	
Pirata sp.			2		1			1	
Schizocosa sp.								2	
Family: Mimetidae (Mimetids)									
Mimetus sp.					1				
Mimetus puritanus		1				1			
Family: Oxyopidae (Lynx Spiders)									
Oxyopes aglossus								1	
Oxyopes salticus			1		1		1	1	
Family: Pisauridae (Nursery-web Weavers)									
Dolomedes triton					1				
Pisaurina mira		9	4		1		1		
Family: Salticidae (Jumping Spiders)		1	3	1	1		10		
Agassa cyanea					1			1	
Hentzia sp.		2	1			1	1	4	

	CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
Hentzia mitrata					1				
Hentzia palmarum								1	
Icius sp.			1				1	1	
Icius elegans				1					
Maevia inclemens						1		2	
Marpissa sp.		1							
Marpissa formosa					9				
Marpissa pikei				2	1		18		
Metaphidippus sp.			1	4	7		8	9	
Metaphidippus galathea				9	7		5	9	
Metaphidippus protervus		3				2			
Phidippus sp.		4		12	7	14	16	4	
Phidippus princeps				1			2		
Sassacus papenhoei							2	1	
Thiodina sp.								2	
Thiodina puerpera		1		2	2		1		
Zygoballus sp.				1					
Family: Theridiidae (Comb-footed Spiders)									
Euryopis quinquemaculata			1						
Spintharus flavidus						1			
Theridion sp.		2	2						
Theridion differens					4				
Theridion frondeum			4						
Theridula opulenta			1			1			
Thymoites unimaculata		2			1	2			
Family: Thomisidae (Crab Spiders)			1			3		1	
Misumenoides aleatorius				4	3		2	2	
Misumenops sp.		1	1	1		1		1	
Philodromus sp.			1		5		1	3	
Philodromus bimuricatus					2				
Philodromus marxii						1			
Philodromus placidus								1	
Misumenops asperatus					1	1			
Synema parvula		2	3	2	1	18		3	
Tibellus sp.				3				1	
Tibellus duttoni							1		
Tmarus sp.						1			
Xysticus sp.			1	3			1		
Xysticus auctificus							1		
Xysticus funestus							1		

	CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHROPOGENIC LANDS
Order: Acarina (Mites and Ticks)									
Mites		3	27	21	42		14	10	
Dermacentor variabilis (Dog Tick)		1		4	2		2	4	
CLASS INSECTA (Insects)									
Order: Collembola (Springtails)									
Family: Smynthuridae		1	6	5	22	4		6	
Order: Plecoptera (Stoneflies)									
Family: Nemouridae									
Nemoura sp.		1							
Order: Odonata (Dragonflies and Damselflies)									
Family: Coenagrionidae (Stalk-winged Damselflies)									
Enallagma sp.					8				
Ischnura sp.			1						
Family: Libellulidae (Skimmers)									
Tetragoneuria cynosura					1				
Order: Orthoptera (Grasshoppers & Crickets)									
Family: Acrididae (Grasshoppers)							2	1	
Aeropedellus sp.					1		1		
Arphia sp.				8					
Family: Gryllacrididae (Leaf-rolling Grasshoppers)			12			6			
Family: Gryllidae (Crickets)			6			7	4	1	
Nemobius sp.								1	

	CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE ROWS	ANTHRO-POGENIC LANDS
Family: Gryllotalpidae (Mole Crickets)									
Gryllotalpa sp.				1				1	
Family: Mantidae (Praying Mantis)				1					
Family: Phasmidae (Walking Stick)									
Pseudosermyle sp.		1		2		1			
Family: Tetrigidae (Grouse Locust)									
Paratettix sp.		1							
Tettigidea sp.			1	2	4			1	
Family: Tettigoniidae (Katydids)		17		13	36		11	27	
Order: Coleoptera (Beetles)									
Family: Anobiidae (Death Watch Beetles)									
Eutylistus sp.		2				1			
Lasioderma sp.						1			
Family: Anthicidae (Ant-like Flower Beetles)									
Anthicus sp.			1						
Family: Anthribidae (Fungus Weevils)									
Brevibarra sp.							1		
Piesocorynus sp.			2				15		
Family: Bruchidae (Bean Weevils)									
Acanthoscelides sp.		1		3	4		2		
Althaeus sp.				2					
Megacerus sp.							2		
Meibomeus sp.					1				
Stylantheus sp.							1		
Family: Buprestidae (Metallic Wood Borers)									
Agrilus sp.							1		
Anthaxia sp.						1			

	CREEKS & STREAMS	CREEK FOREST	FLOODPLAIN FOREST	LOWLAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGEROWS	ANTHROPOGENIC LANDS
Mastogenius sp.							30		
Family: Byrrhidae (Pill Beetles)									
Byrrhus sp.							2		
Family: Byturidae (Fruitworms)									
Byturus sp.		2							
Family: Cantharidae (Soldier Beetles)									
Cantharis sp.		11	4	3	1	6		3	
Chauliognathus sp.				3				1	
Podabrus sp.		2	3	1	5			5	
Trypherus sp.						8			
Family: Carabidae (Ground Beetles)									
Abacidus sp.								1	
Galeritula sp.				1					
Lebia sp.		2							
Platynus sp.					1				
Pterostichus sp.				1					
Scarites sp.				1					
Tachys sp.							1		
Family: Cerambycidae (Longhorn Beetles)									
Asemum sp.							1		
Mecas sp.							2		
Molorchus sp.						1			
Oberea sp.				1					
Family: Chrysomelidae (Leaf Beetles)					5		4	1	
Altica sp.					2			1	
Anomoea sp.				3				2	
Babia sp.							10		
Baliosus sp.			1						
Calligrapha sp.		2							
Chaetocnema sp.		3	1	4	19		1	7	
Chlamisus sp.					1		2	1	
Colaspis sp.			6						
Galerucella sp.					1				

	CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
Crepidodera sp.				3	3			1	
Cryptocephalus sp.				3	3		1		
Derocrepis sp.			1			1		1	
Euparius sp.								3	
Exema sp.					1				
Galeruca sp.							2		
Graphops sp.				1					
Hornaltica sp.								3	
Longitarsus sp.			2	1	1			1	
Megalostomis sp.				15					
Microrhopala sp.		1							
Myochrous sp.				1	1				
Oedionychus sp.			2	2	1			2	
Pachybrachys sp.				2			3		
Paria sp.			4		1	1	1		
Rhabdopterus sp.		1							
Saxinis sp.							1		
Stenispa sp.								5	
Strabala sp.				1			3		
Systena sp.					1				
Trichaltica sp.							1		
Xanthonia sp.								12	
Family: Cleridae (Checkered Beetles)									
Enoclerus sp.								1	
Ischydnocera sp.				1	4				
Phyllobaenus sp.							5	2	
Family: Coccinellidae (Ladybird Beetles)				3	1	1	1	1	
Adalia sp.					1				
Anatis sp.						1			
Anisostica sp.							1		
Brachyacantha sp.				1	1				
Coccinella sp.							2		
Coleomegilla sp.				2	9		1	3	
Cycloneda sp.					1		4	1	
Hippodamia sp.				1					
Hyperaspidius sp.		1							
Hyperaspis sp.		1		1	3				
Family: Cucujidae (Flat Bark Beetles)									
Telephanus sp.				2					

	CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
Family: Curculionidae (Weevils)									
Acalyptus sp.			1						
Allomimus sp.							1		
Apion sp.							1		
Baris sp.							1		
Ceutorhynchus sp.				1					
Cosmobaris sp.				1					
Cossonus sp.			1						
Cylindrocopturus sp.				1	2				
Dryophthorus sp.					2				
Epicaerus sp.					3				
Eugnamptus sp.		2		1					
Gymnaetron sp.							2		
Hyperodes sp.				1					
Lepidophorus sp.					2		1		
Mesagroicus sp.				2					
Notaris sp.			4						
Odontocorynus sp.				3					
Pachyphanes sp.								2	
Phyxelis sp.		1							
Pissodes sp.				1					
Plesiobaris sp.		3							
Polydrusus sp.							3		
Pseudobaris sp.							2		
Rhinoncus sp.			1				1		
Sitophilus sp.		1	3	1	4	14	6		
Sphenophorus sp.					4				
Tachypterellus sp.		1				1			
Tanymecus sp.				5	1		6		
Thysanocnemis sp.					1				
Tychius sp.								5	
Tyloderma sp.		6							
Family: Cryptophagidae (Silken Fungus Beetles)									
Loberus sp.		1							
Family: Dermestidae (Skin Beetles)									
Dearthrus sp.				1	4				
Dermestes sp.				3			6		
Cryptorhopalum sp.			2		2				

	CREEKS & STREAMS	CREEK FOREST	FLOODPLAIN FOREST	LOWLAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGEROWS	ANTHROPOGENIC LANDS
Family: Elateridae (Click Beetles)									
Conoderes sp.							1		
Hemicrepidius sp.		2							
Melanactes sp.		1							
Melanotes sp.						8			
Oedostethus sp.						1			
Family: Erotylidae (Pleasing Fungus Beetles)									
Triplax sp.								1	
Family: Euglenidae (Ant-like Leaf Beetles)									
Elonus sp.		8			1	1			
Emelinus sp.						2			
Family: Languriidae (Lizard Beetles)									
Acropteroxys sp.				1					
Languria sp.							1		
Family: Lathridiidae (Minute Brown Scavanger Beetles)									
Melanophthalma sp.						1			
Family: Melandryidae (False Darkling Beetles)									
Allopoda sp.								1	
Pentaria sp.						4			
Family: Mordellidae (Tumbling Flower Beetles)									
Mordellistena sp.		4		3	5	12	13	2	
Family: Orthoperidae (Minute Fungus Beetles)									
Orthoperus sp.		2							

	CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
Family: Phalacridae (Shining Flower Beetles)									
Acylomus sp.								3	
Corylophodes sp.					2				
Phalacrus sp.				1			6		
Family: Pselaphidae (Short-winged Mold Beetles)									
Sonoma sp.			2						
Family: Ptilodactylidae (Toed-winged Beetles)									
Ptilodactyla sp.		2							
Family: Scarabaeidae (June Beetles)									
Trichiotinus sp.							1		
Family: Staphylinidae (Rove Beetles)									
Arpedium sp.						1			
Hapalaraea sp.						1			
Lathrobium sp.			1						
Lispinus sp.		2							
Philonthus sp.							1		
Order: Thysanoptera (Thrips)		6	2	20	39		17	42	
Order: Psocoptera (Book Lice)									
Family: Polypsocidae				1				1	
Family: Pseudocaeciliidae							3		
Order: Hemiptera (True Bugs)									
Family: Berytidae (Stilt Bugs)									
Jalysus sp.		1			2			1	

	CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
Family: Coreidae (Squash Bugs)		8	5	45	3	3		3	
Acanthocephala sp.						1			
Ceraleptus sp.				2			1		
Family: Cydnidae (Nego Bugs)									
Corimelaena sp.		2		4			5	1	
Sehirus sp.							2		
Family: Lygaeidae (Chinch Bugs)				2	8	1			
Cymus sp.					2			1	
Ischnodemus sp.				2			1	13	
Ischnorrhynchus sp.					1				
Oedancala sp.								2	
Orthaea sp.					1				
Phlegyas sp.				15			1	15	
Family: Miridae (Plant Bugs)		6		2	3		6	12	
Adelphocoris sp.			6	2			3	42	
Chlamydatus sp.					1				
Deraeocoris sp.		2			2	3			
Dichrooscytus sp.		1							
Fulvius sp.		1							
Lopidea sp.					1			5	
Lygus sp.							20	2	
Microsynamma sp.							1		
Miris sp.				2				5	
Neoborus sp.					2				
Platytylellus sp.							1		
Poecilocapsus sp.		1							
Strongylocoris sp.				9			2	1	
Trigonotylus sp.					1				
Family: Nabidae (Damsel Bugs)									
Nabis sp.		4			1		1	1	
Family: Pentatomidae (Stink Bugs)				1			1	1	
Podops sp.				1					

	CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
Family: Reduviidae (Assassin Bugs)							1		
Atrachelus sp.		1							
Family: Termatophylidae (Termatophylids)									
Hesperophylum sp.			1						
Family: Tingididae (Lace Bugs)									
Corythuca sp.					1				
Order: Homoptera (Leafhoppers)									
Family: Aphididae (Aphids)			9	12	7	5	42	5	
Georgiaphis sp.			2						
Family: Cercopidae (Spittle Bugs)				1					
Lepyronia sp.			1				6		
Family: Cicadellidae (Leafhoppers)		3	8	7	65	1	48	30	
Aceratagallia sp.		1	3		5			3	
Arundanus sp.					2			7	
Balclutha sp.		7	1	1				4	
Chlorotettix sp.					1			10	
Cicadula sp.			2					2	
Cloanthanus sp.		2		3	3		17	2	
Doleranus sp.		1							
Draeculacephala sp.				2	10			6	
Driotura sp.							1		
Empoasca sp.		4	5	3	13	1	15	14	
Erythroneura sp.		23	3		6			1	
Euscelis sp.				4	3		12	5	
Forcipata sp.				2					
Graminella sp.					68				
Graphocephala sp.		4							
Hebecephalus sp.							1		
Macrosteles sp.				15	55		38	14	
Oncometopia sp.		1							
Ophiola sp.				1			1		
Paraphlepsius sp.		2	2			5			
Ponana sp.							1		

	CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
Scaphoideus sp.						1			
Stragania sp.				9					
Tinobregmus sp.			1						
Family: Cixiidae									
Cixius sp.			1				3		
Family: Delphacidae		2	13	5		10	5	4	
Delphacodes sp.		4			5	3	5	3	
Liburina sp.								2	
Family: Membracidae (Treehoppers)				1			1		
Ceresa sp.								1	
Cyrtolobus sp.						1			
Stictocephala sp.				4	2		2	4	
Family: Psyllidae (Jumping Plant Lice)							1		
Aphalara sp.				3	4		21		
Freysuila sp.			3	1	2			1	
Pachypsylla sp.				1	1				
Paratrioza sp.		1		3	4	3	3	1	
Paurocephala sp.		3		2					
Rhinopsylla sp.							1		
Trioza sp.		1					1		
Order: Neuroptera (Lacewings)									
Family: Hemerobiidae (Brown Lacewings)									
Hemerobius sp.		1		1					
Order: Trichoptera (Caddisflies)									
Family: Hydropsychidae (Seine-making Caddisflies)									
Hydropsyche sp.						1			
Order: Lepidoptera (Butterflies and Moths)		9	7	5	2	12	11	28	
Family: Geometridae (Measuringworms)		2	1			2	1		

	CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
Family: Hesperiidae (Skippers)		1		1					
Family: Lasiocampidae (Tent Caterpillars)					2				
Family: Lycaenidae (Gossamer-winged Butterflies)		1							
Family: Noctuidae (Owlet Moths)		7	5	1	3	1	3	2	
Family: Nepticulidae		3					2		
Family: Tineidae (Clothes Moths)							1		
Family: Pyralidae (Snout Moths)		1				6	2	2	
Family: Saturniidae (Giant Silkworms)					1				
Family: Satyridae (Wood Nymphs)				1					
Order: Diptera (Flies)									
Family: Agromyzidae (Leaf Miners)									
Agromyza sp.				4					
Cerodontha sp.			1	3	2		7		
Family: Anthomyiidae (Root Maggot Flies)									
Proboscimyia sp.						1			
Family: Asilidae (Robber Flies)									
Psilonyx sp.						1			
Family: Cecidomyiidae (Gall Gnats)		14		6	2	3	2	9	
Family: Ceratopogonidae (Biting Midges)			11						
Alluaudomyia sp.						5			
Atrichopogon sp.		3		4	59	4	2	3	
Bezzia sp.		2			1	7			
Culicoides sp.		1	8		2				
Dasyhelea sp.				7	25	2		5	
Forcipomyia sp.		1					4		
Stilobezzia sp.		18							

	CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
Family: Chamaemyiidae (Aphid Flies)									
Chamaemyia sp.								1	
Leucopis sp.			1						
Pseudodinia sp.		2				1		1	
Family: Chironomidae (Midges)		34	48	21	172	59		21	
Family: Chloropidae (Frit Flies)									
Cetema sp.			5		13	2	4	1	
Chlorops sp.					13				
Dactylothyrea sp.					18				
Diplotoxa sp.		1				2			
Elachiptera sp.		3	9			2	1	2	
Hippelates sp.		3		1			4	23	
Lasiopleura sp.					40		1		
Meromyza sp.					4				
Oscinella sp.		26	21	92	278	1	4	41	
Parectecephala sp.					2				
Thaumatomyia sp.				1	5				
Tricimba sp.		2	2	1			1		
Family: Clusiidae (Clusiids)									
Clusia sp.						2		1	
Czernyola sp.					1				
Sobarocephala sp.					1				
Family: Culicidae (Mosquitoes)									
Anopheles sp.		11	8						
Isostomyia sp.						3			
Psorophora sp.		3						1	
Toxorhynchites sp.			2						
Family: Dolichopodidae (Long-legged Flies)									
Aphrosylus sp.			14					1	
Argyra sp.		10	3	26	28		14	39	
Asyndetus sp.				1	1		3	2	
Condylostylus sp.				8	4	2	2	3	
Dolichopus sp.		3	14					1	
Enlinia sp.								1	

	CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
Gymnopternus sp.		8	4		18	3			
Hydrophorus sp.		1	1			4			
Keirosoma sp.				1					
Medetera sp.						3			
Micromorphus sp.				2					
Paracleius sp.		3	13			13			
Parasyntormon sp.			1						
Pelastoneurus sp.			1	1	7			1	
Peloropeodes sp.		1	13			4			
Rhaphium sp.					1	4			
Sciapus sp.		5							
Sympycnus sp.						2			
Thinophilus sp.		32	14		2	29		3	
Family: Drosophilidae (Fruit Flies)									
Chymomyza sp.		5	3			1			
Cladochaeta sp.								1	
Clastopteromyia sp.		5	4			1			
Drosophila sp.			2			1	1		
Leucophenga sp.					1	2			
Mycodrosophila sp.		3	1						
Pseudiastata sp.			1					2	
Scaptomyza sp.		5	6		4	1			
Family: Ephydridae (Shore Flies)									
Leptopsilopa sp.					1				
Notiphila sp.					1				
Family: Empididae (Dance Flies)									
Axelempis sp.								2	
Chelifera sp.		3							
Empis sp.								1	
Euthyneura sp.							1		
Leptopeza sp.					2	1			
Niphogenia sp.				1					
Oreothalia sp.						4			
Platypalpus sp.								3	
Rhamphomyia sp.			5					1	
Syndyas sp.				2				1	
Syneches sp.			3						
Tachydromia sp.				1					
Tachyempis sp.					1				

	CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
Tachypeza sp.		1							
Family: Lauxaniidae (Lauxaniid Flies)									
Camptoprosopella sp.					1				
Chaetocoelia sp.						1		1	
Minettia sp.		7	2			3			
Neogriphoneura sp.		1	3	1					
Pseudogriphoneura sp.		17	10						
Trigonometopus sp.			1						
Xenochaetina sp.								1	
Family: Muscidae (House Flies)									
Chaetogenia sp.				1					
Coenosia sp.		3		7	9		3	6	
Lasiops sp.		1							
Limnospila sp.									
Lispocephala sp.					1				
Schoenomyza sp.						2			
Steinella sp.			3						
Family: Mycetophilidae (Fungus Gnats)					3				
Brachypeza sp.						1			
Mycomya sp.			1						
Neuratelia sp.								3	
Platyura sp.						1			
Family: Milichiidae (Milichiids)									
Paramyia sp.		3							
Phyllomyza sp.				2					
Family: Opomyzidae (Opomyzid Flies)									
Geomyza sp.					1				
Family: Otitidae (Pictured-winged Flies)									
Chaetopsis sp.				3	6		1		
Family: Phoridae (Hump-backed Flies)									
Hypocerca sp.			1						

	CREEKS & STREAMS	CREEK FOREST	FLOODPLAIN FOREST	LOWLAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGEROWS	ANTHROPOGENIC LANDS
Megaselia sp.		12	3	3		48		3	
Pseudacteon sp.			5						
Trineurocephala sp.						1			
Family: Pipunculidae (Big-headed Flies)									
Chalarus sp.					1	1			
Pipunculus sp.					3				
Family: Platystomatidae (Picture-winged Flies)									
Rivellia sp.					1				
Family: Psilidae (Carrot-rust Fly)									
Chyliza sp.				1					
Family: Psychodidae (Moth Flies)									
Psychoda sp.		2	1						
Family: Rhagionidae (Snipe Flies)									
Dialysis sp.						2			
Rhagio sp.						1			
Family: Scatopsidae (Minute Black Scavengers)									
Scatopse sp.					1				
Swammerdamella sp.			2	1	1				
Family: Sciaridae (Dark Winged Fungus Gnats)									
Sciara sp.		9	4	3	5	35	7	10	
Family: Sciomyzidae (Marsh Flies)									
Dictya sp.					4				
Family: Sepsidae (Sepsids)									
Nemopoda sp.		1							

	CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
Sepsis sp.		1		3		1		2	
Family: Sphaeroceridae (Small Dung Flies)									
Scatophora sp.		2	2						
Family: Stratiomyidae (Soldier Flies)									
Beris sp.			1					1	
Microchrysa sp.						1			
Pachygaster sp.		1							
Family: Syrphidae (Hover Flies)									
Chrysogaster sp.				4					
Chrysotoxum sp.									
Epistrophe sp.				1					
Psilota sp.				2					
Xanthogramma sp.				6	1			1	
Family: Tabanidae (Horse Flies)									
Chrysops sp.		1			1				
Tabanus sp.								1	
Family: Tachinidae (Tachinid Flies)								1	
Hemyda sp.					1				
Meigenia sp.					1				
Parademoticus sp.				1					
Family: Tethinidae (Tethinid Flies)									
Pelomyia sp.								1	
Family: Tipulidae (Crane Flies)						1			
Austrolimnophila sp.		1							
Dicranoptycha sp.		3				7			
Elliptera sp.		1							
Erioptera sp.				3	3	1		2	
Conomyia sp.			5						
Limnophila sp.			4		1				
Limonia sp.		19						6	
Longurio sp.					2			1	

	CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
Pseudolimnophila sp.		1	1						
Tipula sp.		1							
Family: Trichoceridae (Winter Crane Flies)									
Diazosma sp.		1							
Order: Hymenoptera (Bees and Wasps)									
Family: Andrenidae (Mining Bees)							1		
Family: Braconidae (Braconid Wasps)						2	1	2	
Adelius sp.							3		
Apanteles sp.					3	1			
Atanycolus sp.		1	7	2	1	1	2	4	
Bracon sp.		8				1			
Braunsia sp.							1		
Centistes sp.								1	
Chelonus sp.		2	2	1	1			1	
Doryctes sp.							3		
Dyscoletes sp.		2							
Earinus sp.		1							
Eubadizon sp.						1			
Euphorus sp.					1				
Euurbracon sp.		1							
Gnaptodon sp.					1	1			
Heterospilus sp.			1		1			1	
Iphiaulax sp.				1	1				
Macrocentrus sp.			1						
Mesotages sp.					2				
Meteorus sp.			1			3		1	
Microctonus sp.					1			3	
Monolexis sp.		4							
Opius sp.		11			2	13		1	
Perilitus sp.				1				1	
Plumarius sp.								1	
Psenobolus sp.							1		
Pygostolus sp.			2	2				1	
Rhaconotus sp.		1	1				1	1	
Urosigalphus sp.				1					
Family: Ceraphronidae (Ceraphronids)		3	1	3	7	2		6	
Family: Chalicididae (Chalcid Wasps)			1						

	CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
Family: Cynipidae (Gall Wasps)		4	3	5	1	3	11	2	
Family: Diapriidae (Diapriids)		1	2		2				
Family: Dryinidae (Dryinids)								1	
Family: Encyrtidae (Encyrtids)			4	1	6	8	8	5	
Family: Eulophidae (Eulophids)		8	7	17	56	7	28	20	
Family: Eupelmidae (Eupelmids)		1		3	2		1	1	
Family: Eurytomidae (Wheat Jointworm)				11	5		18	11	
Family: Figitidae (Figitids)					1	3			
Family: Formicidae (Ants)									
Brachymyrmex depilis			1						
Camponotus sp.		32	2			12		1	
Camponotus americanus						6			
Camponotus castaneus				1				1	
Crematogaster lineolata		20		5	5	37	1	13	
Dolichoderus sp.					1				
Formica sp.		6		1		4	5	4	
Iriodomyrmex pruinosus					4		2		
Lasius sp.		11	17	2		6	6	12	
Leptothorax sp.								1	
Leptothorax curvispinosus		39	35	1	1	141	5	40	
Monomorium minimum		1		10	27		126	34	
Myrmica spatulata			2			1			
Paratrechina sp.					1		1		
Prenolepis imparis						1			
Stenamma sp.							1		
Tapinoma sessile		10	6	7	6		2	4	
Tetramorium caespitum						4			
Family: Halictidae (Halicitid Bees)				1			4	2	
Family: Ichneumonidae (Ichneumon Wasps)		3		3		4	2	1	
Aptesis sp.		2							
Brachycyrtus sp.						1			
Cidaphus sp.		1	4						
Itoplectus sp.								1	
Labium sp.					1				

	CREEKS & STREAMS	CREEK FOREST	FLOOD-PLAIN FOREST	LOW-LAND OLD FIELD	PONDS & BANKS	UPLAND FOREST	UPLAND OLD FIELD	HEDGE-ROWS	ANTHRO-POGENIC LANDS
Megastylus sp.								1	
Mesochorus sp.						3			
Obisiphaga sp.			8						
Phytodietus sp.			1						
Polyaulon sp.			1						
Promethes sp.			2						
Syrphophilus sp.		1							
Family: Megachilidae (Leaf-cutting Bees)							2		
Family: Mymaridae (Fairyflies)		1	1		2	3		7	
Family: Ormyridae (Ormyrids)								2	
Family: Perilampidae (Perilampids)		2	2		2		2		
Family: Platygasteridae (Platygasterids)		3	2	9	4	25	21	18	
Family: Proctotrupidae (Proctotrupids)			1			2		1	
Family: Pteromalidae (Pteromalids)		4	5	7	13	2	8	12	
Family: Scelionidae (Scelionids)			1	1	2		6	2	
Family: Tenthredinidae (Sawflies)		1							
Family: Torymidae (Torymids)		1	2	3		2	2		
Family: Trichogrammatidae (Trichogrammatids)						1			
Family: Vanhorniidae (Vanhorniids)							1		

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APPENDIX H

Sample Site Locations

Each location includes the county, township coordinates, section number, and the quarter of the quarter-section containing the site. Site location within this area is distinguished by a physical feature. In some cases, three sites are located near the confluence of a tributary to Brushy Creek. These sites have the same site number but are differentiated as being: on the tributary (T), on the main stream above the confluence (AC), or on the main stream below the confluence (BC). Exact positions of these sites are given in yards from the confluence.

SITES 32
Williamson, T-8-S, R-4-E, Section 25
The Southwest quarter of the Southwest quarter of Section Twenty-five (25), at the confluence of the tributary to Brushy Creek (AC:40, BC:70, T:50).

SITES 68
Saline, T-9-S, R-5-E, Section 4
The Northwest quarter of the Northwest quarter of Section Four (4), at the confluence of the tributary to Brushy Creek (AC:50, BC:50, T:50).

SITE 67
Saline, T-9-S, R-5-E, Section 4
The Southeast corner of the Southwest quarter of the Northwest quarter of the Northwest quarter of Section Four (4), immediately North of the point where the road crosses the tributary to Brushy Creek.

SITES 80
Saline, T-8-S, R-5-E, Section 33
The Southeast quarter of the Southeast quarter of Section Thirty-three (33), at the confluence of the tributary flowing from the North to Brushy Creek (AC:35, BC:30, T:40).

SITES 127
Saline, T-9-S, R-5-E, Section 3
The Northeast quarter of the Southeast quarter of Section Three (3), at the confluence of the tributary to Brushy Creek (AC:40, BC:50, T:40).

SITE 85
Saline, T-9-S, R-5-E, Section 3
The Southwest quarter of the Southwest quarter of Section Three (3), immediately East of the point where the road crosses the tributary to Brushy Creek.

SITES 125
Saline, T-9-S, R-5-E, Section 1
The Northeast corner of the Southeast quarter of the Southwest quarter of Section One (1), at the confluence of the tributary to Brushy Creek (AC:40, BC:400, T:40).

SITE 134
Saline, T-9-S, R-5-E, Section 7
The Northeast corner of the Southeast quarter of the Northwest quarter of Section Seven (7), on the main stream of the tributary to Bankston Fork, 50 yards South of the junction with tributary from the East.

SITE 136
Saline, T-9-S, R-5-E, Section 8
The Northeast corner of the Southeast quarter of the Southwest quarter of Section Eight (8), 20 yards below the confluence of the two tributaries flowing from the North.

SITE 144
Saline, T-9-S, R-5-E, Section 17
The Southwest corner of the Southeast quarter of the Northeast quarter of Section Seventeen (17), immediately West of the point where the road from the North crosses the tributary to Bankston Fork.

SITE 152
Saline, T-9-S, R-5-E, Section 15
The Southwest quarter of the Northwest quarter of Section Fifteen (15), immediately West at the point where the road crosses the tributary to Bankston Fork.

SITE 38
Williamson, T-9-S, R-4-E, Section 24
The Northeast corner of the Northwest quarter of the Northwest quarter of Section Twenty-four (24), immediately West of the point where Illinois 13 crosses Bankston Fork.

SITE 174
Saline, T-9-S, R-5-E, Section 11
Immediately East of the bridge where Bankston Fork enters the Northeast quarter of the Southeast quarter of Section Eleven (11).

SITE 300
Saline, T-9-S, R-6-E, Section 8
The Northeast quarter of the Northwest quarter of Section Eight (8), immediately East of the bridge crossing.

Appendix I. Results of stream water analyses by site. Alkalinity, acidity, and total hardness as mg/l $CaCO_3$.

Site	Temp. (°C)		O_2	pH	Alk.	Acid.	Total	Total Fe	Mn	SO_4	NO_3-N	PO_4	Turb.	S.M.[a]
	Air	Water	(ppm)				Hard.	(mg/1)	(mg/1)	(mg/1)	(mg/1)	(mg/1)	(FTU)	(ml/1)
32AC														
Feb.	2	0	14.3	7.27	55	5.2	156	0.36	0.17	133	0.4	0.04	11	tr[b]
Mar.	16	10	10.4	7.28	47	4.3	124	0.57	0.06	99	0.6	0.07	21	tr
Apr.	22	17	8.7	7.60	82	5.0	219	0.20	0.14	188	0.1	0.03	8.8	tr
May	22	20	7.2	7.48	88	5.5	191	0.17	0.17	134	0.3	0.04	4.5	tr
July	23	22	2.8	6.85	45	12.4	80	1.3	0.19	53	tr	0.06	40	0.1
Aug.	21	21	2.6	7.30	94	9.0	99	0.31	1.2	21	0.0	0.04	12	tr
Sept.	12	16	6.8	7.22	62	8.0	92	0.60	0.02	39	0.1	0.04	18	tr
32BC														
Feb.	3	0	14.7	7.26	54	5.4	155	0.35	0.14	133	0.4	0.11	10	tr
Mar.	16	10	10.5	7.31	45	4.5	122	0.61	0.07	96	0.5	0.06	20	tr
Apr.	20	16	9.0	7.62	81	4.7	210	0.21	0.13	185	0.1	0.05	7.5	tr
May	22	20	7.4	7.50	86	4.6	184	0.17	0.15	135	0.3	0.05	4.9	tr
July	22	23	5.4	7.18	63	9.6	124	1.0	0.30	56	0.1	0.06	30	0.1
Aug.	20	21	3.6	7.54	122	7.5	119	0.10	0.80	27	0.0	0.02	9.9	tr
Sept.	12	16	7.2	7.23	63	7.4	94	0.53	0.05	43	0.1	0.05	9.7	tr
32T														
Feb.	4	0	14.4	6.68	16	5.8	66	0.20	0.25	64	0.3	0.04	3.8	tr
Mar.	16	8	10.6	6.65	15	6.3	58	0.43	0.17	54	0.9	0.03	7.9	tr
Apr.	20	15	8.5	6.77	21	7.4	74	0.18	0.26	70	0.1	0.05	3.8	tr
May	22	18	6.0	6.57	27	13.4	64	0.15	0.11	58	0.4	0.04	2.4	tr
July														
Aug.														
Sept.														

Appendix I. Continued.

Site	Temp. (°C) Air	Temp. (°C) Water	O_2 (ppm)	pH	Alk.	Acid.	Total Hard.	Total Fe (mg/1)	Mn (mg/1)	SO_4 (mg/1)	NO_3-N (mg/1)	PO_4 (mg/1)	Turb. (FTU)	S.M.[a] (ml/1)
68AC														
Feb.	2	0	14.2	7.24	41	4.4	144	0.46	0.55	138	0.4	0.03	10	tr
Mar.	20	10	10.4	7.11	31	5.2	115	0.80	0.25	113	0.3	0.04	23	tr
Apr.	22	17	9.5	7.62	64	3.6	204	0.21	0.21	190	0.1	0.05	7.0	tr
May	25	21	8.0	7.62	70	3.8	194	0.12	0.14	174	0.0	0.04	3.1	tr
July	24	24	5.0	6.96	44	10.0	96	3.9	0.36	70	0.0	0.07	75	tr
Aug.	24	23	2.5	7.03	63	14.1	82	6.2	1.6	55	0.0	0.02	220	0.1
Sept.	15	17	8.1	7.20	42	6.6	157	0.56	0.20	164	0.0	0.03	12	tr
68BC														
Feb.	2	0	13.5	7.25	41	4.2	145	0.45	0.63	137	0.3	0.03	10	tr
Mar.	20	11	10.0	7.20	32	4.3	120	0.69	0.31	112	0.4	0.06	21	tr
Apr.	22	17	8.4	7.60	63	3.7	214	0.21	0.24	195	0.1	0.05	11	tr
May	25	21	7.5	7.57	70	4.3	209	0.11	0.23	195	0.0	0.02	3.6	tr
July	24	24	4.4	7.14	50	8.1	111	1.8	0.20	82	0.0	0.09	60	tr
Aug.	25	23	3.7	7.18	84	14.4	128	3.7	1.7	78	0.0	0.01	120	0.1
Sept.	15	16	6.6	7.21	45	6.5	205	0.53	0.36	198	0.1	0.05	12	tr
68T														
Feb.	2	0	14.4	7.02	28	5.0	236	1.4	3.8	214	tr	0.01	7.8	0.7
Mar.	20	11	10.2	7.08	24	4.4	220	1.4	2.4	214	0.4	0.03	25	0.2
Apr.	22	18	9.1	7.54	45	3.7	399	0.25	3.6	388	0.1	0.06	4.6	tr
May	25	20	7.4	7.52	68	5.2	580	0.06	4.1	580	tr	0.07	2.7	tr
July	24	22	3.3	7.21	81	11.2	350	0.40	1.4	301	0.0	0.06	4.0	tr
Aug.														
Sept.	15	15	6.5	7.82	75	4.1	590	0.30	2.0	540	0.0	0.02	1.6	tr

Appendix I. Continued.

Site	Temp. (°C) Air	Temp. (°C) Water	O_2 (ppm)	pH	Alk.	Acid.	Total Hard.	Total Fe (mg/1)	Mn (mg/1)	SO_4 (mg/1)	NO_3-N (mg/1)	PO_4 (mg/1)	Turb. (FTU)	S.M.[a] (ml/1)
67														
Feb.	6	1	13.6	6.83	22	6.8	244	1.3	4.4	252	0.0	0.01	11	0.1
Mar.	23	14	10.4	6.92	20	5.4	215	1.4	2.6	231	0.5	0.01	29	0.4
Apr.	23	17	8.3	7.36	33	4.0	407	0.42	3.9	420	0.1	0.05	7.5	tr
May	26	20	7.5	7.48	45	4.4	610	0.22	8.0	640	0.1	0.04	3.6	tr
July	26	22	5.7	7.27	71	10.0	406	0.28	1.9	380	tr	0.06	8.0	tr
Aug.	25	22	5.2	7.29	77	10.8	469	0.17	0.32	417	0.1	0.02	9.3	tr
Sept.	17	16	9.2	7.79	88	5.4	650	0.54	4.3	600	0.1	0.02	9.7	tr
80AC														
Feb.	7	2	12.8	7.50	53	2.9	190	0.34	0.73	175	0.7	0.03	5.5	tr
Mar.	13	11	10.2	7.26	33	3.8	123	0.68	0.33	114	0.5	0.04	22	0.1
Apr.	23	17	8.4	7.61	63	3.8	213	0.22	0.32	195	0.1	0.07	6.8	0.1
May	27	21	7.9	7.58	66	3.9	197	0.14	0.11	177	tr	0.04	3.3	tr
July	26	25	6.1	7.01	38	8.6	104	1.8	0.43	89	tr	0.10	45	tr
Aug.	27	24	3.0	6.89	52	17.2	102	0.58	0.68	71	tr	0.02	7.5	tr
Sept.	17	16	7.3	7.27	51	6.6	199	0.67	0.32	184	tr	0.05	14	tr
80BC														
Feb.	7	2	13.1	7.46	52	3.0	190	0.35	0.74	175	0.6	0.02	6.2	tr
Mar.	13	11	10.8	7.24	33	3.9	112	0.73	0.40	117	0.5	0.04	22	0.1
Apr.	23	17	8.5	7.64	63	4.0	211	0.22	0.27	196	0.3	0.05	7.3	tr
May	27	22	7.6	7.53	65	4.0	199	0.15	0.11	178	0.1	0.04	3.8	tr
July	26	24	4.4	6.92	38	8.5	100	2.7	0.47	80	tr	0.11	90	tr
Aug.	27	23	2.2	6.94	38	10.8	61	2.5	1.4	40	0.0	0.03	100	0.1
Sept.	18	17	7.8	7.29	49	7.4	203	0.76	0.39	184	0.1	0.04	14	tr

Appendix I. Continued.

Site	Temp. (°C)		O_2	pH	Alk.	Acid.	Total	Total Fe	Mn	SO_4	NO_3-N	PO_4	Turb.	S.M.[a]
	Air	Water	(ppm)				Hard.	(mg/1)	(mg/1)	(mg/1)	(mg/1)	(mg/1)	(mg/1)	(ml/1)
80T														
Feb.	7	2	13.4	7.10	63	8.5	186	0.62	0.61	192	0.6	0.02	16	tr
Mar.	13	10	10.4	7.04	50	9.2	138	1.1	0.27	118	0.4	0.02	37	tr
Apr.	23	17	9.3	7.05	60	11.2	176	0.96	0.62	175	0.2	0.06	24	tr
May	27	20	2.2	6.64	76	32.0	224	0.59	5.5	207	0.3	0.05	20	0.1
July														
Aug.														
Sept.														
127AC														
Feb.	4	2	13.6	7.52	53	2.9	229	0.40	0.69	197	0.8	0.05	8.5	tr
Mar.	14	12	11.0	7.39	41	3.3	160	0.83	0.48	148	0.3	0.05	30	tr
Apr.	18	14	9.9	7.41	46	4.0	147	0.76	0.26	139	0.1	0.05	26	tr
May	25	23	7.7	7.55	68	4.3	198	0.19	0.11	173	0.1	0.03	9.3	tr
July	25	23	3.0	7.05	39	8.2	116	1.0	0.32	104	0.3	0.02	50	0.1
Aug.	26	23	1.9	6.87	40	10.5	69	1.7	1.5	42	0.0	0.01	50	0.1
Sept.	16	14	7.8	7.34	50	5.8	200	0.17	0.02	193	0.1	0.04	3.7	tr
127BC														
Feb.	5	2	13.7	7.52	53	2.9	217	0.44	0.67	201	0.4	0.01	8.3	tr
Mar.	14	11	9.7	7.36	41	3.8	153	1.3	0.45	115	0.3	0.05	34	tr
Apr.	18	15	9.1	7.40	46	4.1	148	0.77	0.22	143	0.3	0.06	24	tr
May	25	24	6.8	7.56	68	4.2	197	0.18	0.17	170	tr	0.03	6.2	tr
July	25	25	5.7	7.33	42	4.8	114	1.0	0.34	100	0.3	0.03	32	tr
Aug.	26	24	7.2	7.20	42	4.8	68	1.4	1.0	42	0.0	0.01	50	tr
Sept.	16	14	7.7	7.36	50	5.4	200	0.24	0.23	187	0.0	0.02	0.0	0.1

Appendix I. Continued.

	Temp. (°C)		O_2				Total	Total Fe	Mn	SO_4	NO_3-N	PO_4	Turb.	S.M.[a]
Site	Air	Water	(ppm)	pH	Alk.	Acid.	Hard.	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(FTU)	(ml/l)
127T														
Feb.	4	2	12.8	7.47	60	3.9	214	0.31	0.12	205	1.2	0.04	7.8	0.1
Mar.	14	10	10.6	7.07	31	5.1	103	2.1	0.05	100	1.0	0.03	150	tr
Apr.	18	12	9.7	7.35	54	5.3	154	0.49	0.08	167	0.5	0.05	19	tr
May	25	20	4.6	7.26	122	13.8	248	0.15	0.20	265	0.4	0.06	7.6	tr
July														
Aug.														
Sept.														
85														
Feb.	9	4	11.8	7.25	87	8.5	343	0.16	0.13	291	0.6	0.02	4.9	tr
Mar.	15	9	9.5	7.06	57	8.6	212	0.44	0.07	114	0.4	0.07	16	tr
Apr.	15	12	8.6	7.13	77	11.4	261	0.34	0.21	212	0.4	0.03	10	tr
May	28	18	4.6	6.98	92	18.3	324	2.0	0.26	274	0.1	0.06	21	tr
July	27	21	5.9	7.16	94	13.0	401	0.23	0.38	378	tr	0.08	5.2	tr
Aug.	27	22	6.1	7.33	108	13.6	462	0.24	0.94	397	0.1	0.02	5.9	tr
Sept.	17	17	7.6	7.26	125	16.8	437	0.29	0.75	328	0.1	0.01	0.3	tr
125AC														
Feb.	2	2	13.7	7.52	52	2.9	222	0.37	0.59	203	0.7	0.04	7.4	tr
Mar.	14	12	10.8	7.27	39	4.2	155	0.94	0.30	147	0.4	0.04	36	0.1
Apr.	18	14	9.3	7.42	47	4.0	154	0.80	0.18	150	0.3	0.06	24	tr
May	26	23	7.3	7.55	69	4.2	195	0.20	0.16	189	tr	0.04	8.2	tr
July	26	24	6.5	7.31	93	10.4	165	0.58	1.3	126	0.4	0.06	15	tr
Aug.	26	24	4.8	7.14	92	14.5	129	0.97	4.9	82	0.1	0.01	26	tr
Sept.	16	15	7.8	7.44	50	4.7	157	0.21	0.18	133	0.1	0,03	0.7	tr

Appendix I. Continued.

Site	Temp. (°C) Air	Temp. (°C) Water	O_2 (ppm)	pH	Alk.	Acid.	Total Hard.	Total Fe (mg/l)	Mn (mg/l)	SO_4 (mg/l)	NO_3-N (mg/l)	PO_4 (mg/l)	Turb. (mg/l)	S.M.[a] (ml/l)
125BC														
Feb.	16	6	10.9	6.75	42	12.9	258	14.2	0.79	270	1.6	tr	19	tr
Mar.	14	11	9.4	6.72	34	11.8	143	4.0	0.37	169	1.2	0.03	120	0.4
Apr.	18	14	9.8	5.91	10	33.7	173	9.3	0.59	184	0.5	0.01	30	4.0
May	26	23	6.9	3.85	0	102	235	9.4	1.8	375	0.4	0.03	33	0.8
July	26	25	6.4	2.72	0	580	560	103	13	1210	8.2	0.08	6.0	0.1
Aug.	27	24	5.3	2.65	0	830	460	76.6	18	1260	20	0.13	17	tr
Sept.	15	15	8.6	2.87	0	630	390	117	14	960	6.9	0.06	3.7	tr
125T														
Feb.	2	1	14.2	3.47	0	341	302	50.9	4.0	730	2.4	0.09	45	2.2
Mar.	14	12	10.6	3.37	0	195	140	52.0	2.0	391	1.9	0.01	120	4.1
Apr.	18	14	9.0	2.93	0	412	202	79.6	6.1	830	5.2	0.01	26	1.5
May	26	22	6.8	2.66	0	790	444	109	9.9	1410	20	0.06	14	0.1
July	26	23	6.4	2.48	0	1230	800	156	17	2400	31	0.07	15	0.2
Aug.	27	24	5.3	2.65	0	830	460	341	13	2900	17	0.59	27	tr
Sept.	15	15	7.2	2.47	0	3330	1230	347	84	4500	11	0.74	28	tr
134														
Feb.	9	2	10.3	6.97	27	5.2	134	0.06	0.28	129	0.2	0.00	3.0	tr
Mar.	11	10	10.4	6.85	20	5.3	91	0.35	0.17	83	0.4	0.03	9.2	tr
Apr.	14	12	10.7	6.88	23	5.7	88	0.31	0.16	84	0.1	0.05	6.0	tr
May	22	20	6.0	6.83	35	11.0	95	0.24	0.44	81	0.1	0.02	5.8	tr
July	24	23	2.0	6.81	40	14.4	65	1.2	1.1	41	0.3	0.15	35	0.1
Aug.	21	22	2.2	5.56	6	25.5	35	62.3	1.6	161	0.0	0.00	650	tr
Sept.	11	14	7.7	7.17	48	9.2	172	4.2	0.74	146	0.0	0.03	160	0.1
136														
Feb.	16	7	10.0	7.53	125	4.7	880	0.70	4.8	790	0.1	0.02	16	tr
Mar.	15	10	10.4	6.95	44	10.7	444	16.2	1.8	414	0.3	0.03	12	0.1
Apr.	12	11	10.9	7.33	80	9.0	600	1.4	2.3	570	0.0	0.03	10	tr

Appendix I. Continued.

	Temp. (°C)		O_2				Total	Total Fe	Mn	SO_4	NO_3-N	PO_4	Turb.	S.M.[a]
Site	Air	Water	(ppm)	pH	Alk.	Acid.	Hard.	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(FTU)	(ml/l)
136 Continued														
May	24	16	7.4	7.65	175	11.8	1140	0.88	5.1	970	0.1	0.04	8.2	tr
July	26	24	5.4	7.83	219	11.2	1790	0.14	1.2	1800	0.6	0.02	4.8	tr
Aug.	25	23	4.9	7.81	220	10.0	1900	0.15	1.2	1590	0.3	tr	25	tr
Sept.	14	15	7.5	7.70	186	14.4	1600	0.20	0.23	1040	tr	0.03	0.0	tr
144														
Feb.	16	5	10.4	7.48	50	3.5	334	0.95	1.1	291	0.1	0.01	6.4	0.0
Mar.	15	10	9.9	7.01	22	4.8	150	0.90	0.43	137	tr	0.04	27	tr
Apr.	10	12	9.7	7.20	33	5.0	192	0.39	0.63	162	0.1	0.06	8.6	tr
May	24	21	6.5	7.54	100	7.5	650	0.16	1.2	560	0.1	0.04	5.5	tr
July	26	25	3.5	7.35	72	9.0	195	0.75	1.7	158	0.5	0.07	35	0.1
Aug.	25	23	3.0	7.47	113	11.5	790	2.8	5.8	820	0.2	0.02	16	0.2
Sept.	14	15	7.8	7.46	61	7.0	373	1.9	0.54	301	0.1	0.03	20	tr
152														
Feb.	16	3	9.8	6.90	36	9.3	223	0.09	0.84	222	tr	0.03	5.2	tr
Mar.	13	10	10.0	6.65	17	6.5	105	0.64	0.28	102	0.2	0.03	31	tr
Apr.	22	13	8.8	6.88	26	6.2	124	0.31	0.45	104	0.0	0.09	8.6	tr
May	25	22	3.6	7.11	83	15.1	216	0.69	1.8	183	0.1	0.10	12	tr
July	26	24	1.1	7.32	100	12.0	165	1.9	2.0	99	0.4	0.02	26	0.1
Aug.	25	24	3.2	7.30	95	11.2	132	1.7	3.2	44	0.1	0.13	33	tr
Sept.	15	16	4.5	7.19	86	13.8	150	0.74	1.1	81	0.0	0.12	7.1	tr

APPENDIX J

FISH SPECIES WHICH MAY OCCUR IN THE DELTA EXPANSION AREA[1]

Family Petromyzontidae (Lampreys)

Ichthyomyzon unicuspis Hubbs & Trautman--silver lamprey

Family Lepisosteidae (Gars)

*_Lepisosteus oculatus_ (Winchell)--spotted gar

Family Amiidae (Bowfins)

Amia calva Linnaeus--bowfin

Family Anguillidae (Eels)

Anguilla rostrata (Lesueur)--American eel

Family Clupeidae (Herrings)

Dorosoma cepedianum (Lesueur)--gizzard shad

Family Umbridae (Mudminnows)

Umbra limi (Kirtland)--central mudminnow

Family Esocidae (Pikes)

Esox americanus Gmelin--grass pickerel

Family Cyprinidae (Minnows and Carps)

*_Campostoma anomalum_ (Rafinesque)--stoneroller
Carassius auratus (Linnaeus)--goldfish
*_Cyprinus carpio_ Linnaeus--carp
Hybognathus nuchalis Agassiz--silvery minnow
*_Notemigonus crysoleucas_ (Mitchill)--golden shiner
Notropis atherinoides Rafinesque--emerald shiner
Notropis boops Gilbert--bigeye shiner
Notropis lutrensis (Baird & Girard)--red shiner
Notropis spilopterus (Cope)--spotfin shiner
Notropis umbratilis (Girard)--redfin shiner
Notropis whipplei (Girard)--steelcolor shiner
Phenacobius mirabilis (Girard)--suckermouth minnow

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[1] Smith (1973).
*Presence verified during this inventory.

*_Pimephales notatus_ (Rafinesque)--bluntnose minnow
*_Pimephales vigilox_ (Baird & Girard)--bullhead minnow
Semotilus atromaculatus (Mitchill)--creek chub

Family Catostomidae (Suckers)

Carpiodes cyprinus (Lesueur)--quillback
Carpiodes velifer (Rafinesque)--highfin carpsucker
Catostomus commersoni (Lacepede)--white sucker
Erimyzon oblongus (Mitchill)--creek chubsucker
Minytrema melanops (Rafinesque)--spotted sucker
Moxostoma erythrurum (Rafinesque)--golden redhorse
Moxostoma macrolepidotum (Lesueur)--northern redhorse

Family Ictaluridae (Catfishes and Bullheads)

*_Ictalurus melas_ (Rafinesque)--black bullhead
Ictalurus natalis (Lesueur)--yellow bullhead
*_Ictalurus punctatus_ (Rafinesque)--channel catfish
Noturus exilis Nelson--slender madtom
Noturus gyrinus (Mitchill)--tadpole madtom
Noturus nocturnus Jordan & Gilbert--freckled madtom
Pylodictis olivaris (Rafinesque)--flathead catfish

Family Aphredoderidae (Pirate Perches)

Aphredoderus sayanus (Gilliams)--pirate perch

Family Cyprinodontidae (Topminnows)

*_Fundulus notatus_ (Rafinesque)--blackstripe topminnow
*_Fundulus olivaceus_ (Storer)--blackspotted topminnow

Family Poeciliidae (Livebearers)

*_Gambusia affinis_ (Baird & Girard)--mosquitofish

Family Atherinidae (Silversides)

Labidesthes sicculus (Cope)--brook silverside

Family Percichthyidae (Sea Basses)

Morone chrysops (Rafinesque)--white bass
Morone mississippiensis Jordan & Eigenmann--yellow bass

Family Centrarchidae (Sunfishes)

Ambloplites rupestris (Rafinesque)--rock bass
Centrarchus macropterus (Lacepede)--flier
*_Lepomis cyanellus_ Rafinesque--green sunfish
*_Lepomis gulosus_ (Cuvier)--warmouth
*_Lepomis humilis_ (Girard)--orangespotted sunfish

*Lepomis macrochirus Rafinesque--bluegill
Lepomis microlophus (Gunther)--redear sunfish
*Lepomis megalotis megalotis (Rafinesque)--central longear sunfish
Micropterus dolomieui Lacepede--smallmouth bass
Micropterus punctulatus (Rafinesque)--spotted bass
*Micropterus salmoides (Lacepede)--largemouth bass
Pomoxis annularis Rafinesque--white crappie
*Pomoxis nigromaculatus (Lesueur)--black crappie

Family Percidae (Perches and Darters)

Etheostoma asprigene (Forbes)--mud darter
Etheostoma chlorosomum (Hay)--bluntnose darter
*Etheostoma gracile (Girard)--slough darter
Etheostoma nigrum Rafinesque--johnny darter
Etheostoma spectabile (Agassiz)--orangethroat darter
Percina caprodes (Rafinesque)--logperch
Percina maculata (Girard)--blackside darter
Percina phoxocephala (Nelson)--slenderhead darter
Stizostedion vitreum (Mitchill)--walleye

APPENDIX K

Aquatic Invertebrates of the Delta Expansion Area

PHYLUM CHLOROPHYTA (Green Algae)

Chlorophyceae
- *Chaelophora* sp.
- *Cladophora* sp.
- *Closteriopsis* sp.
- *Closterium* sp.
- *Cosmarium* sp.
- *Desmidium* sp.
- *Gloeocystis* sp.
- *Mougeotia* sp.
- *Oedogonia* sp.
- *Pandorina* sp.
- *Pediastrum* sp.
- *Pleurotaenium* sp.
- **Scenedesmus* sp.
- *Sphaerocystis* sp.
- *Tetraedron* sp.
- *Treubaria* sp.
- *Volvox* sp.
- *Zygnema* sp.

PHYLUM CHRYSOPHYTA (Yellow-green Algae)

Bacillariophyceae
- *Asterionella* sp.
- *Cymbella* sp.
- *Fragilaria* sp.
- *Gomphonema* sp.
- *Gyrosigma* sp.
- *Melosira* sp.
- *Navicula* sp.
- *Pinnularia* sp.
- *Rhoicosphaeria* sp.
- *Rhopalodia* sp.
- *Stauroneis* sp.
- *Synedra* sp.

Chrysophyceae
- *Dinobryon* sp.
- *Mallomonas* sp.

PHYLUM EUGLENOPHYTA (Euglenoids)

Euglenophyceae
- *Euglena* sp.
- *Phacus* sp.

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*Only collected outside the Delta expansion area.

PHYLUM MYXOPHYTA (Blue-green Algae)

- Myxophyceae
  - *Anabaena* sp.
  - *Aphanocapsa* sp.
  - *Lyngbya* sp.
  - *Oscillatoria* sp.

PHYLUM PYRROPHYTA (Dinoflagellates)

- Dinophyceae
  - *Ceratium* sp.

PHYLUM PROTOZOA (Protozoans)

- Class Sarcodina
  - Order Heliozoida (Sun Animalcules)
    - Family Actinophryidae
      - *Actinosphaerium* sp.

- Class Ciliata (Ciliates)
  - Order Peritrichida
    - Family Vorticellidae
      - *Vorticella* sp.

PHYLUM ROTATORIA (Rotifers)

- Class Digononta
  - Order Bdelloidea

- Class Monogononta
  - Order Flosculariaceae
    - Family Testudinellidae
      - *Testudinella* sp.
  - Order Ploima
    - Family Brachionidae
      - *Brachionus angularis*
      - *Kellicottia* sp.
      - *Keratella cochlearis*
      - *Keratella quadrata*
      - *Keratella valga*
      - *Lepadella* sp.
      - *Notholca* sp.
      - *Platyias patulus*
      - *Platyias quadricornis*
    - Family Lecanidae
      - *Lecane* sp.
      - *Monostyla* sp.
    - Family Synchaetidae
      - *Polyarthra* sp.
    - Family Trichocercidae
      - *Trichocerca* sp.

PHYLUM ANNELIDA (Segmented Worms)

Class Oligochaeta (Earthworms)
Order Lumbriculida
Family Lumbriculidae
*_Lumbriculus_ sp.
Order Haplotaxida
Family Naididae
Chaetogaster sp.
Ophidonais sp.
Pristina sp.
Family Tubificidae
*_Ilyodrilus_ sp.
Limnodrilus sp.
Peloscolex sp.

PHYLUM COELENTERATA (Coelenterates)

Class Hydrozoa (Hydroids)
Order Hydroida
Family Hydridae
*_Hydra_ sp.

PHYLUM PLATYHELMINTHES (Flatworms)

Class Turbellaria (Free-living Flatworms)
Order Tricladida
*Family Planariidae

PHYLUM MOLLUSCA (Mollusks)

Class Gastropoda (Univalve Mollusks)
Order Basommatophora
Family Physidae
Physa sp.

PHYLUM ARTHROPODA (Joint-footed Animals)

Class Arachnida (Spiders and Mites)
Order Acarida (Mites)
Family Arrenuridae
Arrenurus sp.

Class Crustacea (Crustaceans)
Order Amphipoda (Sand Hoppers)
Family Gammaridae
Crangonyx sp.
Order Decapoda (Crayfish)
Family Astacidae
Cambarus sp.
Orconectes sp.
*_Procambarus_ sp.

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*Only collected outside the Delta expansion area.

Class Crustacea--Continued
  Order Isopoda (Aquatic Sow Bugs)
    Family Asellidae
      Asellus _forbesi_
      Asellus _intermedius_
      Lirceus _fontinalis_
  Order Ostracoda (Seed Shrimps)
  Order Copepoda
    Nauplii or larvae
    Suborder Harpacticoida
    Suborder Cyclopoida
      Family Cyclopidae
    Suborder Calanoida
      Family Diaptomidae
        Diaptomus sp.
  Order Cladocera (Water Fleas)
    Family Bosminidae
      Bosmina _longirostris_
    Family Chydoridae
      Alona sp.
      Chydorus _sphaericus_
      Leydigia _quadrangularis_
      Pleuroxus _denticulatus_
    Family Daphnidae
      Ceriodaphnia sp.
      Daphnia sp.
      Scapholeberis _kingi_
      Simocephalus sp.

Class Insecta (Insects)
  Order Collembola (Springtails)
    Family Poduridae
      Podura _aquatica_
  Order Plecoptera (Stoneflies)
    Family Nemouridae
      Nemoura _varshava_
    Family Perlidae
      Perlesta _placida_
    Family Perlodidae
      Isoperla _decepta_
  Order Ephemeroptera (Mayflies)
    Family Bactidae
      Callibaetis sp.
      *_Centroptilum_ sp.
      Neocloeon sp.
      Pseudocloeon sp.
    Family Caenidae
      Caenis sp.
    Family Heptageniidae
      Epeorus sp.
      Heptagenia sp.
      Stenonema sp.

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*Only collected outside the Delta expansion area.

- Class Insecta--Continued
  - Order Ephemeroptera--Continued
    - Family Ephemeridae
      - _Hexagenia limbata_
    - Family Leptophlebiidae
      - *_Paraleptophlebia_ sp.
    - Family Siphlonuridae
      - _Ameletus lineatus_
      - _Siphlonurus_ sp.
  - Order Odonata (Dragonflies and Damselflies)
    - Family Coenagrionidae (Stalk-winged Damselflies)
      - *_Argia_ sp.
      - _Enallagma_ sp.
      - _Ischnura_ sp.
      - _Nehalennia_ sp.
    - Family Cordulegastridae
      - _Cordulegaster obliquus_
    - Family Gomphidae
      - _Dromogomphus spinosa_
    - Family Libellulidae (Skimmers)
      - _Celithemis elisa_
      - _Erythemis_ sp.
      - _Libellula luctuosa_
    - Family Lestidae
      - _Lestes_ sp.
  - Order Coleoptera (Beetles)
    - Family Anthicidae (Ant-like Flower Beetles)
    - Family Curculionidae (Weevils)
      - _Tanymecus_ sp.
    - Family Dytiscidae (Predaceous Diving Beetles)
      - _Bidessus_ sp.
      - _Hydroporus_ sp.
      - *_Laccophilus_ sp.
    - Family Dryopidae (Long-toed Water Beetles)
      - *_Helichus_ sp.
    - Family Gyrinidae (Whirligig Beetles)
    - Family Haliplidae (Crawling Water Beetles)
      - _Peltodytes_ sp.
    - Family Hydrophilidae (Water Scavengers)
      - *_Helophorus_ sp.
      - _Hydrobius_ sp.
    - Family Elmidae (Drive Beetles)
      - _Dubiraphia_ sp.
      - _Narpus_ sp.
  - Order Hemiptera (True Bugs)
    - Family Corixidae (Water Boatmen)
    - Family Gerridae (Water Striders)
      - _Gerris remegis_
      - _Trepobates_ sp.
    - Family Veliidae (Broad-shouldered Water Striders)
      - _Microvelia americana_

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*Only collected outside the Delta expansion area.

Class Insecta--Continued
- Order Neuroptera (Lacewings)
  - Family Corydalidae
    - *Chauliodes sp.
  - Family Sialidae (Dobsonflies)
    - Sialis sp.
- Order Trichoptera (Caddisflies)
  - Family Hydroptilidae (Micro-caddisflies)
    - *Agruylea sp.
  - Family Hydropsychidae (Seine-making Caddisflies)
    - Cheumatopsyche sp.
  - Family Leptoceridae (Long-horned Caddisflies)
    - *Oecetis sp.
  - Family Limnephilidae
    - *Ironoquia punctitissima
  - Family Phryganeidae (Macro-caddisflies)
    - Ptilostomis sp.
  - Family Psychomyiidae
    - Neureclipsis sp.
    - Polycentropus centralis
  - Family Rhyacophilidae (Primitive Caddisflies)
    - Rhyacophila sp.
- Order Diptera (Flies)
  - Family Ceratopogonidae (Biting Midges)
    - Palpomyia sp.
  - Family Chironomidae (Midges)
    - Subfamily Chironominae
    - Chironomus sp.
    - Cryptochironomus sp.
    - Dicrotendipes sp.
    - Einfeldia sp.
    - Endochironomus sp.
    - Glyptotendipes sp.
    - Kiefferulus sp.
    - Microtendipes sp.
    - Parachironomus sp.
    - Paracladopelma sp.
    - Paralauterborniella sp.
    - Paratendipes sp.
    - Polypedilum sp.
    - Stictochironomus sp.
    - Tribelos sp.
    - Tanytarsini sp.
    - Subfamily Orthocladiinae
    - *Brilla sp.
    - Corynoneura sp.
    - Cricotopus sp.
    - Diplocladius sp.
    - Orthocladius sp.
    - Procladius sp.

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*Only collected outside the Delta expansion area.

- Class Insecta--Continued
    - Subfamily Orthocladiinae--Continued
    - *Psectrocladius* sp.
    - *Trichocladius* sp.
    - Subfamily Tanypodinae
    - *Clinotanypus* sp.
    - *Coelotanypus* sp.
    - *Psectrotanypus* sp.
    - *Tanypus* sp.
    - *Pentaneurini* sp.
  - Family Culicidae (Mosquitoes)
    - *Chauborus* sp.
    - *Wyeomyia* sp.
  - Family Empididae (Dance Flies)
    - *Empis* sp.
  - Family Simuliidae (Black Flies)
    - *Simulium* sp.
  - Family Stratiomyidae (Soldier Flies)
    - *Hermione* sp.
  - Family Tabanidae (Horse Flies)
    - *Chrysops* sp.
    - *Tabanus* sp.
  - Family Tipulidae (Crane Flies)
    - *Hexatoma* sp.
    - *Holorusia* sp.
    - *Pseudolimnophila* sp.
    - *Tipula* sp.

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